ABSTRACT

Title of Document:	DIETARY AND ACCULUTRATION FACTORS INFLUENCING METABOLIC SYNDROME AMONG SOUTH ASIAN AMERICANS IN TWO COMMUNITY HEALTH CENTERS IN MARYLAND
	Saira A. Khan, Ph.D., Nutrition and Food Science, 2014
Directed By:	Professor Dr. Robert T. Jackson, Department of Nutrition and Food Science

South Asian's (SA) have been observed to have higher insulin resistance followed by an altered state of metabolism; however, few studies have attempted to explore the acculturation process and dietary practices of immigrant SA's in the U.S. 1401 South Asian Americans living in Maryland from India, Pakistan, Bangladesh, Sri Lanka, Nepal, Iran, and Afghanistan were selected from two community health clinics to determine the prevalence of metabolic syndrome (MetS) in this study group and its indicators. The prevalence of MetS (51%) in adults was higher than African Americans, European Americans, and Mexican Americans. Overall, Indians had the highest percent of MetS 54% compared to Bengali 51%, Pakistani 49%, or Other SA 44%. The results suggest the high prevalence

of MetS among SA may be due to a lack of acculturation in this survey group where 80% were classified as Asian low acculturated. Results from a logistic regression analysis showed that the likelihood of developing MetS was high, but future investigations are needed to confirm the role of acculturation from a more representative sample of SA's.

We also examined the role of acculturation, diet and exercise in South Asians who acquire MetS. We also examined the diet quality using the 2010 guidelines. The low acculturated South Asians had a greater prevalence of MetS and the overall diet quality of the low income South Asians in Maryland needed improvement. The SA male and female mean scores for the healthy eating index-2010 were 71.9 ± 1.9 and 67.9 ± 1.2, respectively. Males were more acculturated, consumed healthier foods, and had a lower percent of MetS compared to females.

DIETARY AND ACCULUTRATION FACTORS INFLUENCING METABOLIC
SYNDROME AMONG SOUTH ASIAN AMERICANS IN TWO COMMUNITY
HEALTH CENTERS IN MARYLAND

SAAHI:SOUTH ASAIN AMERICAN HEALTH INITIATIVE

By

Saira A. Khan

Dissertation submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
2014

Advisory Committee:
Professor Dr. Robert Jackson, Chair
Dr. Nadine Sahyoun
Dr. Mira Mehta
Dr. Bahram Momen
Dr. Tony Whitehead

Dedication

I dedicate this to my mother for the constant support and energy, my father, and my children Asma, Aisha, and Omar who constantly endured. I also dedicate this to my sister, brothers, nephews, and nieces and all the wonderful special friends and neighbors who supported and encouraged my endeavors.

Acknowledgements

I would like to especially thank my advisor Dr. Robert T. Jackson for this impetus support, dedication, and feedback for this research and dissertation. I would like to thank all the committee members Dr. Nadine Sahyoun, Dr. Mira Mehta, Dr. Tony Whitehead, and Dr. Bahram Momen for their involvement, ideas, and responses. A special thanks for Dr. Momen for serving on my committee. I especially thank and appreciate Dr. Qadri and Dr. Sufi for their assistance and allowance for the clinic facilities and to all the medical clinic staff for making data collection a wonderful experience. I would like to thank the subjects of my study for agreeing to be interviewed. I would like to thank the College of Agriculture and National Resources and the Department of Nutrition and Food Science for funding my graduate education. Thanks to all the Department Staff and personnel for making this an enjoyable journey.

Table of Contents

This Table of Contents is automatically generated by MS Word, linked to the Heading formats used within the Chapter text.

List of Tables

Chapter 1: Introduction

There are over 2 million individuals of South Asian (SA) origin in the U.S. SA's represent one of the largest and fastest growing ethnic groups in the U.S. and the prevalence of Metabolic Syndrome (MetS) has likewise increased in the U.S. over the past decade (1). Compared to other ethnicities, SA have at least a two-fold increased risk of CVD, myocardial infarction, type 2 diabetes mellitus (T2D), and cardiovascular death (2). Studies also show that there are health disparities between SA Americans and ethnic minority groups in the U.S. placing them at higher risks for morbidity and mortality from non-communicable chronic diseases such and CVD (3-5). MetS is a major problem worldwide and a public health concern that dramatically increases a person's risk of developing T2D and CVD (6-8). According to the American Heart Association (AHA), an estimated 50 million Americans have MetS and CVD is the leading cause of disability in the United States. CVD is the single largest killer for men and women accounting for 80 million Americans suffering a heart attack, angina pectoris or both. Heart disease is the leading cause of death in the United States (8).

The MetS is an aggregation of the most dangerous cardiovascular disease risk factors: hyperglycemia, hypertriglyceridemia, raised blood pressure, low high density lipoprotein-cholesterol and obesity that dramatically increase a person's risk of developing diabetes, and CVD(9). CVD refers to a wide variety of heart and blood vessel diseases, including coronary heart disease, stroke, and peripheral artery disease. The diagnosis of MetS is with the presence or treatment for 3 of the 5 previous risk factors. Other possible MetS components that received attention included; microalbuminuria, hyperuricemia, changes in clotting factors, chronic inflammation, and fatty liver(10). Prior to the 2009 harmonized definition of MetS, there were a number of definitions for diagnosing MetS among ethnic groups with no well-accepted criteria.

Currently, there is still controversy regarding obesity measures and cut off values for those measures in ethnic groups.

MetS prevalence increases with age and varies by gender. The prevalence of MetS among adults 20 years of age and over in the U.S., 2010 was reported to be 23% and continues to be a major public health problem (11). Males and females 40-59 years of age were about three times as likely as those 20-39 years of age to be diagnosed with MetS. Males 60 years of age and over were more than four times as likely as the youngest age group to meet the criteria for being diagnosed with MetS. SA's seem to have a high prevalence of cardiovascular and metabolic risk factors at a young age despite seemingly protective demographic characteristics such as income and education. Studies (12, 13) suggest that coronary heart disease is diagnosed five to ten years earlier in SA compared with other populations and it is often diagnosed before the age of 40.

Culture and behavioral patterns also play a role in health disparities among ethnic minority groups. Cultural norms and acculturation of immigrant populations play a role in the development of disease. Anthropologists (14) have suggested that ethnicity should not be reduced to a socioeconomic variable because it alone cannot explain the discrepancy that exists in diseases. Rather ethnicity should be used as a tool to better understand the patterns and norms of behavior.

Poor diet, lack of physical activity, and smoking are the leading modifiable risk factors of CVD, leading to high rates of CVD among the poor, less educated, and minorities (15, 16). Dietary factors that play a major role in heart disease are consumption of saturated fat, trans fats, dietary cholesterol, and the imbalance between energy intake and energy expenditure leading to obesity (16). According to the 2003-2004 National Health and Nutrition Examination Survey

(NHANES), researchers evaluated the diet quality of the entire U.S. population and also compared low-income and higher-income individuals. The results showed that the Healthy Eating Index Scores (for those ≥ age 2 yrs. and older), for all components were below the maximum possible points (see appendix) except for total grains and meat and beans. Compared to higher-income participants, low-income participants had significantly lower component scores for total vegetables, dark green and orange vegetables and legumes, and whole grains. Low-income individuals also had a higher component scores (consumed more) for sodium. Several studies in India have implicated high dietary fat intake with the development of obesity and hyperglycemia and a high dietary intake of fat has been reported in Asian Indians (17). A higher than average energy intake from total fat (percent kcal from fat) has been reported in migrant SA in the U.S. compared to other ethnic groups (18). Non-vegetarian migrant SA's have higher BMI values than vegetarians due to an increased intake of high-fat dairy products. Migrant SA who consume high amounts of dietary fats have higher BMI and more risk factors for CVD "possibly contributed by changes in lifestyle and consumption of excess energy of fats" following immigration (19).

In the U.S., the NHANES (National Health and Nutrition Examination Survey) is a national program of studies designed to assess the health and nutritional status of adults and children. This national study began collecting data on the Nation in the 1960's focused on chronic disease of adult's ages 18-79 years. The surveys were conducted in two year cycles with different focuses. The National focus for the second survey (1963-1965) was children ages 6-11 years, and the third survey was (1966-1970) youths ages 12-17 years (20). In 2011-2012, an Asian subsample was added that categorizes all East and South Asians together (20) even though studies in Asia have shown variations of diet, culture, and disease between East and South

Asians. Oversampling of the Asian population, survey materials were translated into Mandarin Chinese, both traditional and simplified, Korean, and Vietnamese. In addition, videos were available in Hindi and other non-Asian languages (20). Most U.S. studies have enrolled low numbers of SA's, thus there is a need to study more individuals from this population to understand MetS prevalence and the indicators that predict MetS. Cross-sectional studies and clinical trials have enrolled relatively few participants of SA origin in the U.S. Considering the high prevalence of T2D and CVD in the SA subpopulation, there is an urgent need to identify individuals with MetS at an early age to implement prevention plans and to delay the development of these diseases. Screening SA Americans for obesity, hypertension, insulin resistance, lipid disorders, and the MetS is advisable to develop a plan for early risk modification. It is important to identify and treat immigrant populations without health insurance who would otherwise seek treatment from hospitals for chronic disorders.

The purpose of the current study was to determine the overall prevalence of MetS in a cross section of low-income SA Americans who utilize 2 community health centers in Maryland. We will examine:

➢ the prevalence of MetS prevalence by gender

➢ the prevalence of MetS prevalence among SA ethnic groups

➢ the indicators of MetS, then indicators of MetS among men and women, and the indicators of MetS among the SA ethnic groups

➢ the prevalence of MetS using different markers for obesity (waist circumference vs. body mass index)

- ➤ the variables that predict having MetS in SA, variables that predict having MetS among men and women, and variables that predict having MetS among SA ethnic groups.

- ➤ acculturation status as a predictor of MetS in SA men and women, and among SA ethnic groups.

- ➤ the Healthy Eating Index (HEI-2010) score for SA and its relationship to MetS and acculturation status and among men and women.

Our secondary analysis was to conduct extensive case studies on SA participants in order to:

- ➤ better understand the effect of acculturation on beliefs and perceptions of dietary practices and diseases.

- ➤ assess the role of culture on food practices and where SA acquire food items, and what are considered culturally acceptable foods.

Chapter 2: Literature Review

Metabolic Syndrome

<u>Historical Development of Metabolic Syndrome Definition</u>

Metabolic syndrome is the constellation of metabolic risk factors including central obesity, atherogenic dyslipidemia, elevated plasma glucose, elevated blood pressure, prothrombotic and proinflammatory states that directly promote the development of cardiovascular disease and is strongly associated with type 2 diabetes mellitus (21).

Several criteria have been proposed by different organizations for identifying individuals with MetS. Individuals who meet the criteria for MetS are at increased risk for development of CVD and type 2-diabetes. Definitions have been proposed by the World Health Organization (WHO), the European Group for the Study of Insulin Resistance (EGIR), the American Association of Clinical Endocrinologists (AACE), the National Cholesterol Education Program, Adult Treatment Panel III (NCEP ATP III), American Heart Association, National Heart, Lung, and Blood Institute (AHA NHLBI) and the International Diabetes Federation (IDF) (see **Table 1 below**). These criteria are continuously being revised and updated.

Table 1: Proposed Definitions of Metabolic Syndrome including the World Health Organization (WHO), the European Group for the Study of Insulin Resistance (EGIR), the American Association of Clinical Endocrinologists (AACE) and the National Cholesterol Education Program, Adult Treatment Panel III (NCEP ATP III), American Heart Association, National Heart, Lung, and Blood Institute (AHA NHLBI) and the International Diabetes Federation (IDF).

	WHO (1999)	NCEP ATP III (2005)	IDF (2005)	EGIR (1999)	AACE (2003)	AHA NHLBI (2005)
	Diabetes mellitus, impaired fasting glucose, or insulin resistance with two or more of the following:	Three or more of the following:	Central obesity (ethnicity-specific) and two or more of the following:	Nondiabetics with insulin resistance and two or more of the following:		Three of the five risk factors:
Fasting Glucose	≥110 mg/dL; 2-hour glucose ≥140 mg/dL	≥100 mg/dL (6.1 mmol/L)	≥100 mg/dL (5.6 mmol/L) or T2DM diagnosis	≥110 mg/dL (6.1 mmol/L) but nondiabetic	FPG 110-125 mg/dL and 140-200 mg/dL 120 min after a 75 g oral glucose challenge	≥100 mg/dL (5.6 mmol/L) or T2DM diagnosis
Obesity	Central obesity (WHR >.90 in. males or >.85 in. females) and/or BMI >30kg/m2	Waist circumference > 90 cm >80 cm (35in) in females	Ethnic specific	Waist circumference > 94 cm (37.0 in.) in males or ≥80 cm (31.5in) in females		Waist circumference > 90 cm in males or >80 cm in females
Blood Pressure	≥140/90 mm Hg	≥130/≥85 mm Hg	≥130/≥85 mm Hg or treatment	≥140/≥90 mm Hg or treatment	≥130/≥85 mm Hg	≥130/≥85 mm Hg
Triglycerides	≥150 mg dL (1.7 mmol/L)	≥150 mg dL (1.7 mmol/L)	≥150 mg dL (1.7 mmol/L)	≥178 mg dL (2.0 mmol/L)or treatment	≥150 mg dL (1.7 mmol/L)	≥150 mg dL (1.7 mmol/L)
HDL cholesterol	<35 mg/dL (0.9mmol)in males or <39 mg/dL(<1.0mmol/L in females	<40 mg/dL (1.03 mmol/L) in males or <50 mg/dL (1.29 mmol/L) in females	<40 mg/dL (1.03 mmol/L) in males or <50 mg/dL (1.29 mmol/L) in females or treatment	<39 mg/dL (1.0 mmol/L) or treatment	<40 mg/dL (1.03 mmol/L) in males or <50 mg/dL (1.29 mmol/L) in females	<40 mg/dL (1.03 mmol/L) in males or <50 mg/dL (1.29 mmol/L) in females
Other	Microalbuminuria (urinary albumin excretion rate ≥ 20mg/min or albumin:creatinine ratio ≥ 30 mg/g)				Abrnormal uric acid metabolism (plasma uric acid, renal uric acid clearance)	

The World Health Organization (WHO) definition emphasizes insulin resistance as the major underlying risk factor and requires its presence for diagnosis of MetS. The presence of one of the several markers of insulin resistance and at least two risk factors among obesity, hypertension, high triglycerides, reduced HDL cholesterol and micro albuminuria constitutes a diagnosis of MetS. The WHO group allows the term MetS to be used in patients with type 2-diabetes or impaired disposal of glucose under hyperinsulinemic, euglycemic conditions that constitutes diabetes. The WHO indicates that patients with type 2 diabetes mellitus are at higher risk for cardiovascular disease (22). The clinical diagnosis of MetS based on WHO criteria requires the presence of at least two of five risk factors including elevated triglycerides, reduced HDL cholesterol, hypertension, elevated fasting glucose and central obesity, and micro albuminuria.

Insulin resistance is difficult to measure directly in clinical settings and in field studies, thus different markers of indirect evidence of resistance were accepted, i.e., impaired glucose tolerance (IGT) (blood glucose > 140 two hours after a 75g glucose challenge), impaired fasting glucose (IFG) (the American Diabetes Association considers the cutoff to be 100mg/dL) (23), type 2 diabetes mellitus, or impaired disposal of glucose under hyperinsulinemic, euglycemic (normal level of glucose in the blood) conditions.

(EGIR) composed of investigators with various backgrounds convened to pool data on euglycemic hyperinsulinemic clamp experiments performed in many centers in Europe. In 1999, criticizing the WHO definition, they used non-diabetic individuals who have hyperinsulinemia. EGIR proposed to use fasting insulin levels to estimate insulin resistance and impaired fasting glucose as a surrogate for IGT (24). For EGIR elevated fasting plasma insulin plus 2 other factors including abdominal obesity, hypertension, increased triglycerides, decreased HDL

cholesterol and increased fasting plasma glucose define MetS. They also modified HDL cholesterol ($\leq$ 40 mg/dL) compared to WHO ($\leq$ 35mg/dL) and triglycerides (< 180 mg/dL) versus WHO ($\geq$ 150 mg/dL) and added the WC measurement (> 90 cm for men and > 84 cm for women) for central obesity (22). EGIR removed microalbuminuria as a component of MetS (25).

The National Cholesterol Education Program (NCEP), Adult Treatment Panel III (ATP III) proposed alternative clinical criteria for defining MetS in 2001 (25). The criteria do not emphasize a single cause and includes WC as the measure of obesity (21). The cut points for central obesity adopted from 1998 National Institute of Health obesity clinical guidelines were WC $\geq$102 cm ($\geq$ 40 inch) for men and $\geq$ 88 cm ($\geq$ 35 inch) for women (24). These cut points represent the upper quartile of the US population. As some individuals of other ethnic groups i.e., SA and Chinese are susceptible to develop MetS at lower WC, the ATP III noted that individuals who have only 2 metabolic criteria can manifest characteristics of MetS even when the WC is marginally elevated, for example 94-101 cm in men or 80-87 cm in women. The recent revision to the NCEP ATP III reduced the fasting glucose to 100 mg/dL and added an Asian WC measure (>90 cm for males and >80 cm for females) (26).

The American Association of Clinical Endocrinologists (AACE) released a position statement on insulin resistance syndrome in 2003 (25). It identified the major factors for identifying MetS as elevated triglycerides, reduced HDL cholesterol, elevated blood pressure, obesity (WC), elevated fasting and post load glucose. The AACE statement does not provide a specific number of factors for defining the syndrome and allows the diagnosis to rely on clinical judgment.

Other factors used to inform clinical judgment are family history of CVD or type 2 diabetes mellitus, polycystic ovary syndrome and hyperuricemia. By this definition the term

"insulin resistance syndrome" can be applied until the person is diagnosed with type 2-diabetes (25, 27).

The International Diabetes Federation (IDF) proposed new criteria that modify ATP III definition in 2005. This definition requires the presence of abdominal obesity for diagnosis of syndrome. According to the IDF definition, for a person to be defined as having the MetS he/she must have central obesity plus any two of the four additional factors. The additional factors are: 1) Elevated triglycerides level: ≥ 150 mg/dl 2) Reduced HDL cholesterol level: < 40 mg/dl in men and < 50 mg/dl in females or specific treatment for these lipid abnormalities 3) Elevated blood pressure: systolic BP ≥ 130 or diastolic BP ≥ 85 mmHg or treatment of previously diagnosed hypertension 4) Elevated fasting plasma glucose: FPG ≥ 100 mg/dl or previously diagnosed type 2 diabetes" (10). Since abdominal obesity is highly correlated with insulin resistance and other components of MetS, the IDF provides this as a rationale for including it in determining MetS. IDF also emphasizes the use of gender-ethnic specific values for WC when measuring central obesity, as there are clear differences across ethnic populations between overall adiposity, abdominal adiposity and visceral fat accumulation (28, 29).

The more recent 2009 definition agreed upon by the IDF, NHLBI, American Heart Association, World Heart Federation, International Atherosclerosis Society, and the International Association for the Study of Obesity include cut offs for Asian populations, except for Japan. The recommended WC cut points are ≥ 90 cm in men and ≥ 80 cm in women (see **Table 2**).

Table 2: 2009 Ethnic Specific values for waist circumference (9)

*If BMI is > 30 kg/m^2, central obesity is assumed and waist circumference does not need to be measured

Country/Ethnic group		Waist circumference
Europoids	Male	≥ 94 cm
	Female	≥ 80 cm
South Asians Based on Chinese, Malay, and Asian-Indian population	Male	≥ 90 cm
	Female	≥ 80 cm
Chinese	Male	≥ 90 cm
	Female	≥ 80 cm
Japanese	Male	≥ 90 cm
	Female	≥ 80 cm
Ethnic-South and Central Americans	Male	Use South Asian recommendations until more specific data are available
	Female	
Sub-Saharan Africans	Male	Use European data until more specific data are available
	Female	
Eastern Mediterranean and Middle East (Arab) populations	Male	Use European data until more specific data are available
	Female	

In 2009, a new harmonized definition of MetS was developed (30) by the IDF and the AHA/NHLBI. Now the common criteria for clinical diagnosis of MetS based on criteria in **table 3** below recognizes that the risk associated with a particular WC will differ in different populations. The main difference from previous definitions is that formerly the measure for central obesity was an obligatory component in the IDF definition. **Table 4** below shows current international recommendations proposed by the IDF for thresholds of abdominal obesity to be used for MetS. It also lists WC thresholds currently being recommended in several different populations and ethnic groups.

Table 3 : 2009 Harmonized Definition Criteria for Clinical Diagnosis of the Metabolic Syndrome

Measure	Categorical Cut Points
Elevated Waist Circumference	Population-and country-specific
Elevated triglycerides (drug treatment)	≥150 mg/dL (1.7 mmol/L)
Reduced HDL-C (drug treatment)	< 40 mg/dL(1.0 mmol/L) in males < 50 mg/dL (1.3 mmol/L) in females
Elevated Blood Pressure (drug treatment)	Systolic ≥130 and/or diastolic ≥85mmHg
Elevated fasting glucose (drug treatment)	≥100 mg/dL

Table 4: Current Recommended Waist Circumference Thresholds for Abdominal Obesity by Organization

Population	Organization	Recommended WC Threshold for Abdominal Obesity	
		Men	Women
Europoid	IDF	≥94 cm	≥ 80 cm
Caucasian	WHO	≥ 94 cm (increased risk) ≥ 102 cm (still higher risk	≥80 cm (increased risk) ≥88 cm (still higher risk)
United States	AHA/NHLBI (ATP III)*	≥102 cm	≥ 88 cm
Canada	Health Canada	≥102 cm	≥ 88 cm
European	European Cardiovascular Societies	≥ 102cm	≥ 88 cm
Asian (including Japanese	IDF	≥ 90 cm	≥ 80 cm
Asian	WHO	≥ 90 cm	≥ 80 cm
Japanese	Japanese Obesity Society	≥ 85 cm	≥ 90 cm
China	Cooperative Task Force	≥ 85 cm	≥ 80 cm
Middle East, Mediterranean	IDF	≥ 94 cm	≥ 80 cm
Sub-Saharan African	IDF	≥ 94 cm	≥ 80 cm
Ethnic Central and South American	IDF	≥ 90 cm	≥ 80 cm

*Recent AHA/NHLBI guidelines for metabolic syndrome recognize an increased risk for CVD and diabetes at waist-circumference thresholds of ≥ 94 cm in men and ≥ 80 cm in women and identify these as optional cut points for individuals or populations with increased insulin resistance.

The Components for Diagnosis of Metabolic Syndrome

<u>Insulin Resistance</u>

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The term diabetes mellitus describes a metabolic disorder of multiple etiology characterized by chronic hyperglycemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both. It is commonly associated with hypertension, and an excess of epidemiological data suggests that this association is independent of age and obesity. Chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of various organs including the blood vessels, heart, eyes, kidneys, and other organs (31). A state of cellular resistance to insulin action underlies the observed hyperinsulinism. "With the insulin/glucose-clamp technique, in combination with tracer glucose infusion and indirect calorimetry, it has been demonstrated that the insulin resistance of essential hypertension is located in peripheral tissues (muscle), is limited to nonoxidative pathways of glucose disposal (glycogen synthesis), and correlates directly with the severity of hypertension" (32). "Insulin resistance occurs when the liver, skeletal muscle and adipose tissue cells become less sensitive and eventually resistant to insulin and the body cannot make use of the glucose in the blood for energy" (32). In noninsulin-dependent diabetes, the pancreas cannot produce enough insulin or the body tissues become resistant to insulin. Because insulin is less available or is improperly used, the blood sugar level rises gradually above the safety level, taking several years to reach unsafe levels and cause symptoms. "This is also known as adult onset diabetes caused by a complicated interplay of genes, environment, insulin abnormalities (reduced insulin secretion in the beta cells and insulin resistance in muscle cells), increased glucose production in the liver,

increased fat breakdown, and possibly defective hormonal secretions in the intestine" (33). The early signs of diabetes are glucose intolerance and insulin resistance. In insulin-dependent diabetes, the pancreas makes little or no insulin because the insulin-producing beta cells have been destroyed. This can appear at any age but usually occurs between infancy and the late 30's, most typically in childhood or adolescence. If the level of insulin is too low for a long period of time, the body begins to break down its stores of fat for energy causing the release of fatty acids which are then converted to ketone bodies or ketoacids that are toxic at high levels.

Abnormal Body Fat Distribution

Abdominal obesity is quite prevalent in South Asians, and females have greater obesity than males (34). Central or abdominal obesity is one of the main features of MetS and is independently correlated with all other components of the syndrome. Central obesity contributes to insulin resistance, hypertension, dyslipidemia and hyperglycemia and is associated with increased risk of cardiovascular disease and type 2 diabetes mellitus independent of overall adiposity (35-37). WC reflects the amount of abdominal adipose tissue deposits as well as total fat mass, providing a measure of body fat. It also complements BMI in evaluation of obesity related health risks (38-40). Several studies have shown that in assessment of abdominal adiposity WC is complementary or superior to BMI (28, 29). When measuring central obesity, gender-ethnic specific values for WC should be used, since there are clear differences in overall adiposity, abdominal adiposity and visceral fat accumulation among ethnic populations (28, 29). Several studies have indicated that body fat and abdominal adiposity are higher in South Asians compared to Caucasian Americans at similar BMI and lower average WC levels (41). Increased visceral fat in Asian Indians is associated with increased generalized obesity, which is not apparent from their nonobese body mass index (41, 42).

Hypertension

Hypertension is a sustained elevation of blood pressure that is higher than normal for that patient. Persistent hypertension is one of the risk factors for strokes, heart attacks, heart failure and can cause chronic renal failure (43, 44). Hypertension is not only a symptom of a disease but also a disease in itself as it causes damage, mainly to the eyes, the heart, the kidney and the brain. It is important to judge systolic and diastolic pressure individually as we can differentiate between isolated systolic hypertension: only systolic blood pressure is high, diastolic is normal., isolated diastolic hypertension: only diastolic blood pressure is high, systolic is normal., mixed hypertension: both, systolic and diastolic blood pressure are elevated (43). Elevated blood pressure is associated with obesity and glucose intolerance and insulin resistance. The strength of this relation varies in different populations (45, 46). Isolated systolic hypertension is an important risk factor for cardiovascular disease and results primarily from elastic artery stiffening. Hypertension can be classified as essential or secondary. In essential hypertension, no specific medical cause can explain a patient's condition. In secondary hypertension, the high blood pressure is caused by another condition, such as kidney disease or adrenal gland tumor (47).

Atherogenic Dyslipidemia

The dyslipidemia found in individuals with MetS is multi-factorial, and is associated with a cluster of interrelated cardiovascular disease risk factors. Lipoprotein abnormalities including increased triglycerides and apo lipoprotein B, reduced HDL cholesterol, increased small dense LDL particles and increased small HDL particles are main features of atherogenic dyslipidemia. Although results from *in vitro* studies and clinical trials demonstrate strong associations between

oxidative stress and cardiovascular risk, to date still no convincing data are available to suggest that treatment with antioxidants might reduce vascular events. Oxidative modifications of low-density lipoproteins (LDL) represent an early stage of atherosclerosis, and small dense LDL are more susceptible to oxidation than larger, more buoyant particles. Oxidized LDL are independent predictors of subclinical and clinical atherosclerosis. Recent studies suggested that novel therapeutic strategies may take into account the removal of such particles from circulation. Future research is required to explore the potential synergistic impact of markers of oxidative stress and atherogenic dyslipidemia, particularly small dense LDL, on cardiovascular risk (48). Variations in the pattern and magnitude of the dyslipidemia are due to the interaction of genetic factors with environmental influences including diet, physical activity and stress. All of these lipid abnormalities are independently atherogenic (10, 26). The lipid abnormalities in MetS are related to insulin resistance and some mediators like lipoprotein lipase, hepatic lipase and cholesterol ester transfer protein (49, 50). Consumption of excessive dietary lipids (especially saturated fat) are thought to increase CVD risk. Measurement of dietary lipids may give an indication of risk.

Proinflammatory State

The increase in plasma concentrations of proinflammatory mediators-tumor necrosis factor-α (TNF-α), interleukin-6 (IL-6), C-reactive protein (CRP) in obesity, and peripheral blood mononuclear cells (MNC) from obese subjects are found in a proinflammatory state (51). A proinflammatory state can also be characterized by determining proinflammatory risk factors such as oxidized LDL cholesterol, proinflammatory cytokines (e.g., interleukin-1, tumor necrosis factor), adhesion molecules (e.g., intercellular adhesion molecule-1, selectins), inflammatory stimuli with hepatic effects (e.g., interleukin-6) or the products of the hepatic stimulation, such as

serum amyloid A , C-reactive protein (CRP), and other inflammation factors, such as elevated leukocyte count (52). Dietary saturated fatty acids (SFA) and cholesterol are major targets for reducing plasma total and LDL cholesterol as a strategy to decrease cardiovascular disease risk. However, many studies show that excess adiposity attenuates the expected lipid and lipoprotein response to a plasma cholesterol–lowering diet. Diets low in SFA and cholesterol are less effective in improving the lipid profile in obese individuals and in patients with MetS. In contrast, lean persons are more responsive to reductions in dietary SFA and cholesterol. Multiple mechanisms likely contribute to the altered plasma lipid responses to dietary changes in individuals with excess adiposity. The greater rate of hepatic cholesterol synthesis in obese individuals suppresses the expression of hepatic LDL receptors (LDLR), thereby reducing hepatic LDL uptake (53). Insulin resistance develops as a result of adipose-tissue induced inflammation, causing significant changes in enzymes necessary for normal lipid metabolism. In addition, the LDLR-mediated uptake in obesity is attenuated by alterations in neuroendocrine regulation of hormonal secretions (e.g. growth hormone, thyroid hormone, and cortisol) as well as the unique gut microbiota, the latter of which appears to affect lipid absorption. Reducing adipose tissue mass, especially from the abdominal region, is an effective strategy to improve the lipid response to dietary interventions by reducing inflammation, enhancing insulin sensitivity, and improving LDLR binding (54).

Prothrombotic State

The mechanism of the prothrombotic state in metabolic syndrome is also multifactorial. The dysregulation of homeostasis in metabolic syndrome involves endothelial dysfunction, platelet hyperactivity, hypercoagulability and hypofibrinolysis (55). A prothrombotic state is a feature of metabolic syndrome and is characterized by an increase in plasminogen activator

17

inhibitor-1(PAI-1), fibrinogen, tissue factor and factor VII and a decrease in tissue plasminogen activator activity. PAI-1 is a marker of reduced fibrinolytic capacity and is strongly associated with components of metabolic syndrome (10, 56). PAI-1 is synthesized in many tissues, mainly in adipose tissue and vascular endothelial cells. In subjects with MetS, the main production site is the increased adipose tissue mass (55).

Pathogenesis and Clinical Features of Metabolic Syndrome

The MetS is a highly prevalent clinical entity, which is often overlooked and may have far-reaching health implications for the patient. Up to 80% of patients with the metabolic syndrome die as a result of cardiovascular complications (57). Insulin resistance is the central component of this complex syndrome and should be appropriately addressed to ensure the best possible outcome for patients. Associated with this syndrome are hyperuricemia, a procoagulant state (58), hyperhermocysteinemia (59), endothelial dysfunction (60), polycystic ovary syndrome (61, 62), non-alcoholic steatohepatitis (63) and abnormalities suggesting a low-grade, smoldering inflammatory state characterized by elevated C-reactive protein and cytokine levels (64, 65) a cluster of clinical conditions and laboratory findings known as metabolic syndrome. The metabolic syndrome seems to have 3 potential etiological categories: obesity and disorders of adipose tissue; insulin resistance; and a constellation of independent factors (eg, molecules of hepatic, vascular, and immunologic origin) that mediate specific components of the metabolic syndrome. Other factors—aging, proinflammatory state, and hormonal changes—have been implicated as shown above as contributors as well.

Several factors interact to determine an individual's degree of insulin resistance. Genetic predisposition and increasing age are fixed, non-modifiable risk factors (66). Genetic defects

could occur at the pre-receptor (abnormal insulin molecules, insulin antibodies), receptor or post-receptor level. Progressive aging of the population in more developed countries, especially the industrialized nations, has also been linked to the increasing prevalence of insulin resistance (67). It is well documented that insulin resistance increases with age, but this is only true up to middle age and might be partially linked to weight gain (67).

The typical Western lifestyle with high fat, low fiber foods i.e., pizza, French fries, chocolate, etc., lack of exercise and stress, promotes weight gain (central obesity) and therefore insulin resistance (68) which consist of potentially modifiable risk factors. Several studies have confirmed that a high proportion of abdominal fat is a major risk factor for coronary heart disease, type 2 diabetes and related mortality (69). Central obesity is a clinical marker of insulin resistance and reflects the increased amount of visceral fat, which is more metabolically active than peripheral fat and releases large quantities of free fatty acids (70), tumor necrosis factor alpha (TNF-a) (71, 72), leptin (72), resistin (73), and PAI-1 (57, 74).

Increased free fatty acids (lipotoxicity) has recently been demonstrated to cause endothelial dysfunction (75). As with glucose toxicity, this is a partially reversible cause of insulin resistance. TNA-a, a protein (cytokine), has been proposed as the link between insulin resistance and obesity (76). Leptin is a protein (ligand) secreted by fat cells; deficiency in mice causes obesity, hyperinsulinemia and hyperglycemia (77). Resistin is produced by adipocytes and down regulated by the thiazolidinediones (TZD), a well-known treatment of insulin resistance. Its role in human insulin resistance has yet to be determined.

The WHO (Waist-to-hip ratio or BMI) and IDF 2005 IDF (WC > 30 kg/m^2) definitions of MetS both include abdominal obesity, and it is a necessary requirement in the 2005 IDF

definition. That reflects the IDF position-though the pathogenesis of the syndrome is complex, abdominal obesity is a key causative factor (25, 78). Despite the importance of obesity, patients of normal weight can also be insulin resistant. Those are called metabolically obese, normal-weight individuals, typically having increased amount of visceral adipose tissue. With increases in visceral adipose tissues, a higher rate of flux of adipose tissue-derived free fatty acids to the liver through the splanchnic circulation would be expected, while increases in abdominal subcutaneous fat could release lipolysis products into the systemic circulation and avoid more direct effects on hepatic metabolism (24).

In general, with increases in free fatty acid flux to the liver, increased production of very low-density lipoproteins (VLDL) occurs. Under physiological conditions, insulin inhibits the secretion of VLDL into the systemic circulation. In the setting of insulin resistance, increased flux of free fatty acids to the liver increases hepatic triglyceride synthesis. Thus, hypertriglyceridaemia is an excellent reflection of the insulin resistant condition and is one of the important criteria for diagnosis of the MetS (24, 78). The other major lipoprotein disturbance in the metabolic syndrome is a reduction in HDL cholesterol. This reduction is a consequence of changes in HDL composition and metabolism. In the presence of hypertriglyceridemia, a decrease in the cholesterol content of HDL results from decreases in the cholesteryl ester content of the lipoprotein core with variable increases in triglycerides (25). In addition to HDL, the composition of LDL is also modified in a similar way. With fasting serum triglyceride >2.0 mmol/L, almost all patients have a predominance of small dense LDL. This change in LDL composition is attributable to relative depletion of unesterified and esterified cholesterol, and phospholipids, with either no change or an increase in LDL triglyceride (78).

Evidence strongly suggests that free fatty acids are an important link between obesity and insulin resistance and non-insulin dependent diabetes mellitus (NIDDM). First, plasma free fatty acids are elevated in most obese individuals, followed by physiological elevations in free fatty acid concentrations that inhibit insulin stimulated peripheral glucose uptake. Free fatty acids also stimulate insulin secretion in nondiabetic individuals. Some of this insulin is transmitted in the peripheral circulation and is able to compensate for free fatty acid-mediated peripheral insulin resistance. Adverse metabolic consequences of increased free fatty acid flux are extremely wide ranging and include, 1) dyslipidemia and hepatic steatosis, 2) impaired glucose metabolism and insulin sensitivity in muscle and liver, 3) diminished insulin clearance, aggravating peripheral tissue hyperinsulinemia, and 4) impaired pancreatic beta-cell function.

Prevalence of Metabolic Syndrome

MetS is highly prevalent worldwide and parallels the pandemic of obesity and the ageing population of the westernized countries. The prevalence of the syndrome increases with age and currently there are more than 120 million people in the world who suffer from type 2 diabetes and this will increase (79). These figures only represent a small number, as type 2 diabetes is a late feature of MetS. Addressing insulin resistance and its detrimental metabolic sequel early could have a marked effect on CVD mortality and morbidity in these patients. It is a major medical and public health concern in the U.S. (79, 80) with an estimated 47 million U.S residents with MetS (81). The prevalence of the syndrome increases significantly with increasing BMI evident in 4.6% of normal weight, 22.4% of overweight and 59.6% of obese men with a comparable distribution in women (56, 82). Non-Hispanic black males were about one-half as likely as non-Hispanic White and Mexican-American females were about 1.5 times as likely as non-Hispanic white females to meet the criteria. Overweight males were about six times as likely

and obese males were about 32 times as likely as normal weight males to meet the criteria. Overweight females were more than five times as likely and obese females were more than 17 times as likely as normal weight females to meet the criteria (83).

South Asian Population

<u>Conceptualizing Ethnicity</u>

About one quarter of the world's population lives in South Asia (1.5 billion) with an estimate of 25 million outside South Asia. SA's represent one of the largest and fastest growing ethnic groups in the world. The countries represented by South Asia include: India, Pakistan, Iran, Afghanistan, Nepal, Sri Lanka, Bangladesh, Bhutan, and Maldives (84). Conventionally, epidemiologists and social scientists define populations using labels such as age, marital status, sex, race, ethnicity, religious affiliation, socio-economic status and educational level. At one end of the spectrum ethnic minority groups are defined in terms of demographic labels described above, and at the other end more specific markers for ethnicity are used such as race, religion, migration status and other socio-cultural attributes. Defining ethnicity, therefore, is a challenge in itself, since there is no clear definition and there is a growing realization that current definitions (85), largely based on a person's geographical heritage or origin, are increasingly inadequate in making sense of the experience of minority ethnic populations (86). Diversity between ethnic groups further complicates the picture. SA people are a good example of rich diversity within an ethnic group, including language, religion, socio-economic status, cultural traditions, lifestyles, and beliefs. It has been suggested that cultural beliefs or myths about disease or illness can vary considerably amongst different ethnic groups (87). Similarly, issues concerning modesty, to do with religion and culture, in some ethnic minority women may result

in low participation in research studies, and some may prefer to use alternative forms of medicine (88, 89). Additionally, the history of exploitation of ethnic minority people by medical research, methodological/organizational factors and cultural and socio-economic barriers result in poor science participation and raises the issues of health equality (90).

South Asian Demographics

Nationally representative studies regarding the prevalence of the MetS are generally not available from any SA country. Available data from small epidemiological studies indicate that the prevalence of the MetS in Asian Indians varies according to region, extent of urbanization, lifestyle patterns, and socioeconomic/cultural factors (34, 91). Data show that about one third of the urban population in large cities in India has MetS (92-94). Comparable national data on SA in the U.S. are not available for comparison.

According to one small regional study of SA adults (whose mean age was 43 years and 43% of whom were females) residing in the U.S., the prevalence of MetS was 27% (31% men and 17% women). Fifty-nine percent of the cohort had high WC (58% men 62% women) (95). That study was conducted on residents of the San Francisco Bay Area as a part of an ongoing prospective cohort study investigating risk factors for CVD in SA (95) in California. Results from the first randomly selected, population-based study of Asian Indians in South Asia indicate a very high prevalence of diabetes, pre-diabetes, and MetS. The prevalence of type 2 diabetes for adults ≥ 20 years was 17.4%. The prevalence of age-adjusted MetS in SAA was (26.9%) by the original NCEP/ATPIII criteria, and (32.7%) by the modified (NCEP/ATPIII) criteria (which lowered impaired glucose tolerance from 110 to 100 mg/dL) which exceeds that of non-Hispanic

whites (7.8%), non-Hispanic blacks (13%), Hispanic Latinos (10.2%), and Native American/Alaskan natives (15.1%) (94).

According to the world fact book, the U.S population is 313, 232,044 as of July 2011. The age structure of the population was broken down into three age categories 0-14 (20.1% of the population), 15-64 (66.8% of the population), and 65-older (13.1% of the population) (96). The median age is 36.9 years (35.6 yrs. for males and 38.2 yrs. or females). Net migration is >1 migrants per 1,000 population. The urban population is 82% of the population with major cities including New York (19.3 million), Los Angeles-Long Beach and Santa Ana (12.67 million), Chicago (9.13 million), Miami (5.69 million), and Washington D.C (4.42 million) reported in 2009. The ethnic groups represented are 79.9 % white, 15.1 % Hispanic, 12.85 % black, 4.43 % Asian, 0.097% Amerindian and Alaska native, 0.18 % native Hawaiian and other Pacific islander, 1.61% two or more races (July 2007 estimate) (96).

According to the US Census, results from 2010, the state population in Maryland was 5, 773,552. The ethnic breakdown was 58.2% whites, 29.4% Black or African American alone, 0.4 % American Indian and Alaska native alone, and 5.5% Asian alone (97). About 1.68 million South Asians were reported in the Census 2000. According to the Census Bureau, the "Asian Indians" include Bengalese, Bharat, Dravidian, East Indian, or Goanese. And "Other Asian" category includes Bangladeshi, Bhutanese, Burmese, Cambodian, Hmong, Loatian, Indochinese, Indonesian, Iwo Jiman, Madagascar, Malaysian, Maldivian, Nepalese, Okinawan, Pakistani, Singaporean, Sri Lankan, Thai, or Other Asian not specified (97). The population growth rates for Asians of 106% from 1990 to 2000 and 125.6% from 1980 to 1990. In contrast to East Asian Americans, who tend to be concentrated in California and other areas near the Pacific coast, Asian Indians are more evenly distributed throughout the USA (97). Asian Indians are now the

largest Asian American group in the Midwest (at 390,643 followed by the next largest group Chinese at 256,705), and the South (at 370,553 followed by Chinese at 278,590) (98). The average household size for Asians is 3.1; Pakistani-3.7, Bangladeshi-3.7, Sri Lankan-2.8 with about 83% nuclear families and 6% extended families. About 75% of South Asians who work have a bachelor degree or higher. SA have a combined disposable income of $88 billion with an estimated annual buying power of $20 billion (97).

The Washington D.C area is home to the 5th largest SA population in the USA. According to the 2005 U.S. Census, there were over 107,000 SA immigrants in the area (97). In Washington D.C., the Indian community was the largest Asian ethnic group in 2006. In Virginia, a high concentration of South Asians resides in Arlington and Fairfax counties. In fact, census data reveal that the Bangladeshi community grew over 300% between 1990 and 2000 in Fairfax County, VA. In Maryland, a high concentration of South Asians resides in Montgomery, Prince Georges, Howard, and Baltimore counties.

Health & Healthcare Status of South Asians

More than 44 % of SA are poor or near poor compared to all other Asians groups. This in part explains the rates of uninsured and higher rates of Medicaid coverage among these groups. Most Americans get their health coverage through their employer (11%). Asian Americans are less likely to have employer-sponsored health coverage compared to non-Hispanic Whites, and are more likely to be uninsured. There is large variation in health coverage among Asian American subgroups, where employer-sponsored coverage ranges from as low as 49% among Koreans to a high of 77% among Asian Indians. Reliance on Medicaid and other public coverage ranges from 4 percent among Asian Indians to 19% among other Southeast Asians (90). The

uninsured rate is 11% among 3rd plus generation Asians. Health insurance also varies by income.

Asian American adults (11%) rated their health as fair or poor compared to 23% of American Indians, 22% of African Americans, 18% of Hispanics and 13% of non-Hispanic Whites (90). In general, the Asian Americans tend to report better health than that of non-Hispanic Whites and members of other racial and ethnic groups. SA are less likely to rate their health status as fair to poor.

Access to health care is measured by having a usual source of care that is associated with use of preventive services and timely and appropriate medical care (99). Nonelderly Asian Americans are more likely to be without a usual source of care compared to non-Hispanic Whites. Uninsured Asians are more than 4 times as likely to lack a usual source of care compared with insured Asians (99). Access to health care is significantly affected by coverage status. Individuals without insurance are more likely to lack a usual source of care. Among nonelderly uninsured, 52% lack a usual source of care, compared to 46% of non-Hispanic Whites (99). A closer look at Asian Americans reveals variations in health coverage, access to care, and health. For some subgroups, these problems are comparable to the most disadvantaged racial and ethnic groups. More and better data are needed to fully understand the needs of this population in order to develop solutions for improved access to and quality health care (99).

Culture and Acculturation

A simple definition of culture is how we do things and view things in our social groupings. Culture consists of a shared set of values, perceptions, and assumptions, based on a shared history and language (100). Difficulties can often arise in health research when ethnic

minority health disparities are blamed on cultural differences between ethnic minorities groups and the majority population. Ethnicity and culture are a complicated interaction of traditions, religion, socio-economic status, language and health behaviors, all shaped by personal or collective experiences. Ethnic minority cultural identities are continually changing and being reinvented through fusion with majority cultures (101). The health beliefs and behavior of SA people are shaped by their experiences, and are likely to be different to those of second-generation SA people residing away from their home lands. Ethnicity, religion and socio-economic status are all important factors influencing SA people's lifestyles and experiences. Making sense of diversity is a part of the process but there is also a need to recognize that SA people may be different from the general population (102). SA people tend to be more concentrated in inner-city locations and have a propensity to visit medical practices where the general practitioner is likely to speak their language (103).

Acculturation is generally referred to as the psychological processes that take place in individuals of a cultural minority who get into continuous first-hand contact with representatives of a cultural majority (104). "Rapid demographic, nutritional, and economic changes are occurring in SA (92)". Most importantly, globalization of diets and consumption of nontraditional fast foods have occurred at a rapid pace in urban areas. These changes lead to migrants becoming urbanized and mechanized, resulting in nutritional imbalances, physical inactivity, stress, and increased consumption of alcohol and tobacco (91). Migration leads to significant stress due to new environment, social, economic, and language disparities, and job challenges, along with lack of social support leading to a dysmetabolic state (105). Our research hopes to explore the impact of acculturation on the development of unhealthy eating patterns in SAA subgroups and the putative relationship that may have to their chronic disease risk.

Measurement of Acculturation

Acculturation has been defined as "a process intimately related to health behavior and health status of minority populations in a multicultural society"(106). Studies of acculturation have the potential to identify risk factors that might be associated with chronic diseases in immigrant populations. A variety of different studies have shown that acculturation can be used to identify risk behaviors or health behaviors in a variety of immigrant populations, Mexican Americans, Asian Americans, Indian-Americans (107, 108). The Suinn-Lew Asian Self-Identity Acculturation Scale (SL-ASIA) was designed to assess acculturation in Asians (109). It was modeled after a scale that was successfully used in Hispanics, the ARSMA (110). SL-ASIA was found to be a reliable instrument for East Asian Americans and has also been used in South Asians. (111). The scale is used to conduct a cross-cultural examination of Asian acculturation. The overall scale consists of 26 items that categorizes the subjects into "low" or "high" acculturation. It has two parts. The first is a uni-dimensional scale consisting of 21 questions that gives the person one choice as an answer. For example one question states: "How do you identify yourself?" 1. Oriental, 2. Asian, 3. Asian-American, 4. Indian-American, 5. American (109). The second part of the SL-ASIA scale consists of a multidimensional part that consists of five items that allow the responder the free-choice to answer more nuanced questions. For example question 22: Rate yourself on how much you believe in Asian values (ex. About marriage, families, education, work):1 (do not believe) …., 5 (strongly believe in Asian values). These five questions have been added to the original 21 item scale to further classify research participants in way that is consistent with current theories that acculturation is not linear, i.e., uni-dimensional but multidimensional and orthogonal. The multi-dimensional part of the scale

was developed and added to the uni-dimensional part of the scale because of the belief that the linear, uni-dimensional scale was insufficient to capture the complexity of acculturation.

In a recent study looking at carotid intima media thickness as a proxy for CVD (111), who used the SL-ASIA scale on 159 male and female SA immigrants aged 35-65 yrs. The objective of this study was to measure the level of acculturation and its association with Coronary Artery Disease (CAD), sub-clinical CAD, CAD risk factors and T2D in SA immigrants in the United States (111). 68% of South Asian Indians were identified to have high acculturation and ≥ 10 years stay in the U.S., cholesterol level, and family history of CAD were found to be significantly associated with CAD. Additionally, T2D was associated with high acculturation (P<0.001). Their results showed that acculturation (low and high) may play a major role in predisposing immigrant populations to CAD. They suggested that further studies are needed to provide additional information on the impact of acculturation on disease states.

Dietary Assessment

Diet plays an important role in the prevention and treatment of many diseases and health problems (112-114). The ultimate reason to assess human diet is to improve human health. Nutritional problems are at the root of several of the leading causes of death, particularly in developed nations. Food and nutrient intake data are crucial for researching the relationships between diet and these diseases. Particular nutrients (saturated fat) or whole diet patterns may be related to disease susceptibility. There are a variety of dietary assessment techniques including food diaries, food frequency questionnaires, 24-hour dietary recalls, and other techniques. Previous validation research (115) suggests that the 24-hour dietary recall estimates may be useful to characterize a population's median intakes, to discriminate among individuals or

populations with regard to higher vs. lower intakes, to track dietary changes in individuals or populations over time, and to allow examination of interrelationships between diet and other variables.

The 24-hour recall has several strengths. It is inexpensive, quick to administer, and it provides detailed information on specific foods, requires short-term memory. It is well accepted by respondents because they are not asked to keep records, and their expenditure of time and effort is low. This method is considered to be more objective than the dietary history and food frequency questionnaire. There are limitations as well including respondents withholding or altering information about what they ate because of embarrassment, poor memory, or to please interviewer. Dietary assessment methodology has made important advancement in the context of increasingly sophisticated computer technology (116). Computer-assisted dietary assessment hastens data processing, improves procedures, and allows flexibility in accommodating modifications.

A recent advance in this area is the USDA Automated Multiple-Pass Method (AMPM). The automated method consists of three computer systems and an extensive food and nutrient database. Computer systems include: AMPM for collecting food intakes, the Post-Interview Processing System (PIPS) for reformatting data and assigning food codes and Survey Net for final coding, quality review and nutrient analysis (RAPER). Components of the database, The Food and Nutrient Database for Dietary Studies (FNDDS), include food descriptions, food portions and their weights, and nutrients. AMPM is a 5-step computerized dietary recall instrument used in the U.S. National Health and Nutrition Examination Survey (NHANES) (116).

The 5-steps involve a dietary interview that includes multiple passes through the 24-hours of the previous day, during which respondents receive cues to help them remember and describe foods they consumed. The computer assisted version of the 24 hour dietary recall navigates the interviewer through the recall, using standardized questions and providing response options for different foods and beverages. These questions and prompts are described in the methods section below. This research-based, multiple-pass approach is designed to enhance complete and accurate food recall and reduce respondent burden. This automated method for collecting and processing food intake data was to increase the quality and efficiency of food intake surveys. The utility of the AMPM in assessing intake at the population or group level has been supported (116). It is used in quantifying group energy and absolute nutrient intake.

Indices of Dietary Quality

One of the many healthy eating indices reported in literature includes the healthy eating index (HEI). The HEI evaluates intake of various nutrients and food components and assesses consumption of food and food groups. This instrument was developed by researchers at the U.S Department of Agriculture (USDA) for assessing how well the diets of Americans adhere to U.S. federal dietary guidelines (117). The current version, known as the Healthy Eating Index-2010 (HEI-2010), is used by the USDA to assess diet quality as defined by the current Dietary Guidelines for Americans (118). The HEI-2005 was a modified version used to monitor changes in food consumption patterns, to evaluate menus and diet plans, to identify target areas for nutrition education and health promotion programs, and to evaluate those programs.

- Greens and Beans replaces Dark Green and Orange Vegetables and Legumes to emphasize that dark green vegetables and beans and peas (legumes) are the two vegetable subgroups for which intakes are furthest from recommended levels (119).

- Seafood and plant proteins has been introduced for specific choices from the protein food group (119).

- Fatty Acids, a ratio of poly- and mono- unsaturated to saturated fatty acids, replaces Oils and Saturated Fat. This component recognizes the recommendation to replace saturated fat with mono-and polyunsaturated fatty acids (119).

- A moderation component, Refined Grains, replaces the adequacy component, Total Grains, to assess over-consumption. This component is included in the moderation components because the 2010 Dietary Guidelines emphasized that consumption of these foods is too high (119).

The HEI-2010 replaced the last 2005 version and has two components: adequacy and moderation (118). The adequacy components were established to ensure adequacy of nutrient intake while the moderation components are those whose intake should be limited. There are 12 components with the first 9 assessing how adequate the subject's diet is in terms of total fruit (including 100% juice), whole fruit (excluding juice), total vegetables, dark green and orange vegetables and legumes, total grains, whole grains, milk, meat and beans, and oils (non-hydrogenated vegetables oils and oils in fish, nuts, and seeds). The last three components focus on the extent to which intake of saturated fat, sodium, and calories from solid fat, alcoholic beverages and added sugars are limited (see appendix table 1).

In scoring the HEI-2010, the first six components, maximum scores are 5 points and the maximum scores for milk, meat and beans, and oils, saturated fat, and sodium are 10 points. The

maximum score for calories from solid fat, alcoholic beverages, and added sugars is set at 20 because the priority of 2010 Dietary Guidelines for Americans is designed for encouraging the selection of foods that are low in fat and low in added sugars (118). This is because foods containing solid fat, alcoholic beverages and added sugars are currently consumed in amounts that far exceed current recommendations. The HEI-2010 provides a single total score indicating overall diet quality, which can vary between 0 and 100 (the higher the score, the more adherent the diet is to federal dietary recommendations. Scores can be generated for each component or for groups of components to examine intakes of individual components or groups of components (118, 120).

Chapter 3: Methods

Subjects

The Washington D.C area has been identified as one of seven sites where samples were to be taken due to the large population clusters of SA in this area (121). Montgomery County has the largest number of South Asians in the Washington metropolitan area. A systematic sample (explained below) of subjects were obtained from two community health centers for county and other residents connected to religious centers in Maryland. We extracted a cross sectional sample of medical data from patient files from 2 clinics. We also interviewed a subsample of volunteers from the same two clinics.

Medical Data Record Extraction from MCC and ISB clinics

In our work, we used BMI values because in the clinical setting WC measures have not been regularly collected on patients. Therefore, we used a modified harmonized IDF definition for 1000 individuals in our study (explained in detail below). However, on the subjects that we will interview (n = 400), we will be able to obtain their waist circumferences and use the recommended harmonized definition.

The study subjects were SA men and women between ages 20-65 years from two communities where SA's attend in large numbers. Medical record data extraction was obtained by a systematic sampling method. This was conducted by sampling every 2nd file in the clinic after randomly selecting the first one. The population size (N) is the number of patient files, known to be (N) and a specific sample size (n) 1100 was chosen based on the power calculation. We used the following formula for systematic sampling:

$K \leq N/n$. From MCC clinic we collected a population sample size of 1100. Therefore, n=1100, and the total number of files were N=2,600. The formula then became $2.6 \leq 2600/1000$. In order for systematic sampling to be valid, the first item was randomly selected from the first K items in the patient's files until the target sample size of 1100 was achieved. We then looked at every 2nd file from MCC clinic.

In the case of incomplete records or in records that did not meet the study criteria, the next adjacent record was extracted (122).

Patient Interviews

Convenience samples of volunteer patients were interviewed from the same 2 clinics. The patient interviews consisted of a 24-hour dietary recall, Automated Multiple Pass Method (described below) and the Suinn-Lew Asian Self-Identity Acculturation Scale (SL-ASIA) and an additional demographic survey questionnaire was administered during the patients' routine visit.

Inclusion Criteria: Adult South Asian (Pakistan, India, Bangladesh, Sri Lanka, Iran, and Nepal, Afghanistan) men and women, 20-68 years.

Muslim Community Center Clinic

The MCC clinic located in Silver Spring, Maryland offers reduced price services to anyone in need of medical attention. Those in Montgomery County pay smaller fees compared to other counties. The core mission of the clinic is "to provide compassionate high-quality medical care to any adult (18 years and older) without healthcare coverage. It provides care to uninsured, indigent adult residents of the community regardless of race, religion, ethnicity or national

origin. The clinic began services on June 14, 2003 to adults (18 years and older) with funds from grants, and direct financial aid from charitable funds by members (122).

The 20+ Board Certified physicians were volunteers who offered time and some who were paid. The staff consisted of paid medical technicians and over 50 volunteers who handled the clinics administrative tasks, conducted community outreach, conducted healthcare education sessions, coordinated public relation affairs and fundraising (122).

Power Analysis

In this study, a sample size of 1000, with a reasonable minimum effect of α=0.05, a minimum power to detect that effect, and the sample size that would achieve that desired level of power is 80%.

$$n = \sigma^2 \left(z_{1-\beta}\right) + \left(z_{1-\frac{\alpha}{2}}\right) / \left(u_o - u_1\right) 2$$

The power calculation was made for the main affect which is metabolic syndrome, which required 400 subjects. To estimate and compare the individual indicators (total cholesterol, HDL cholesterol, non-HDL cholesterol, triglycerides, systolic BP, diastolic BP, WC, BMI, fasting blood glucose, and fasting insulin, the largest sample size needed is 1,056. We rounded the sample size up to 1000 to make it an even number.

Using a previous variance (26.9) described in Misra et al., given a two-sided significance test conducted at an a level that the true alternative mean is expected to have a confidence interval of $25.9 < \mu < 27.9$ for the prevalence of MetS with 400 samples using the NCEP ATP III definition (121).

We also selected individuals for case studies using in depth interviews to gain a deeper understanding of their food pathways. For this, we used a samples size of 8 SA's residing in the U.S. for less than five years and 8 SA's residing in the U.S. for more than five years.

Definitions for the Metabolic Syndrome

Medical Record Abstraction

Metabolic risk factors were defined according to the new consensus harmonized definition (**Table 4**). We also used a modified definition substituting the BMI for WC and compared the prevalence of MetS using the BMI measures from medical files with the prevalence of MetS using the WC we collected from the interviewed patients. The definition of MetS requires: diabetes mellitus, impaired fasting glucose ($\geq$100mg/dL), or insulin resistance or drug treatment for such, obesity defined by central obesity BMI (≥ 23 kg/m^2) blood pressure $\geq$130 systolic and diastolic $\geq$85 mm Hg or drug treatment, triglycerides $\geq$150 mg/dL, HDL-C <40 mg/dL in males and <50 mg/dL in females (9).

Interviews

The criteria for determining MetS using the harmonized definition (**Table 5**) includes WC cutoffs of (>90cm in males and >80 cm in females of SA origin), triglycerides of $\geq$150 mg/dL or drug treatment, HDL-C of <40 mg/dL for males and <50 mg/dL for females, BP $\geq$130 and diastolic $\geq$85 mmHg or drug treatment, and FPG of $\geq$100 mg/dL or drug treatment.

Assessment of Covariates

The information on covariates and potential confounders such as age (y), BMI (underweight, normal, overweight and obese), marital status (married, unmarried), LDL-C

(mg/dL), smoking habit (current, former and never), physical activity (interview data), income, education, current drug use, was included in the analysis of covariance.

Acculturation

Acculturation was measured using the SL-ASIA scale. The SL-ASIA scale is a 21-item multiple-choice questionnaire covering language (4 items), identity (4 items), friendship (4 items), behaviors (5 items), generation/geographic history/enclave residence (3 items), and attitudes (1 item) (included in appendix). There were also 5 multidimensional items scored on a likert scale. In scoring the scale, a total value was obtained by summing the answers for all 21 items. A final acculturation score was calculated by dividing the total value by 21; a score ranging from 1.0-2.0 connotes low acculturation (Asian), reflecting high Asian identification, a score between 2.1-3.0 connotes biculturation (bicultural) and a score greater than 3.0 connotes high acculturation, reflecting high Western acculturation (109)**.** This total score reflects the overall level of acculturation. Reliability studies show that the Cronbach's alpha for the SL-ASIA scale for Asian Americans was between 0.91 and 0.88, reflecting high reliability (109). A validity study showed that the SL-ASIA scores were significantly correlated with demographic information hypothesized to reflect levels of Asian American identity (109). For example, high SL-ASIA scores were associated with having attended school in the United States over a longer period of time, during which time the SL-ASIA's Asian identity score would have been reduced.

24-hour recall Automated Multiple Pass Method

An online computer assisted interview system was developed by the United States Department of Agriculture (USDA) and is known as the USDA Automated Multiple Pass Method. This 5-step dietary interview included multiple passes throughout the 24 hours food

intake of the previous day, during which respondents received cues to help them remember and describe foods they consumed.

Pass 1: Quick List: collected an uninterrupted listing of all food and beverages consumed the previous day.

Pass 2: Forgotten foods list: collected foods that may have been forgotten during the quick list. Questions probe for foods by categories: nonalcoholic beverages, alcoholic beverages; sweets, savory snacks, fruits, vegetables, cheese, bread and rolls, and other foods.

Pass 3: Time and occasions: collected time and name of eating occasions for each food. Used to sort foods chronologically and group into eating occasions

Pass 4: Detailed and reviewed: collected a detailed description of each food consumed, including amount eaten and additions to the food. Also, we reviewed eating occasions and times between occasions to elicit forgotten foods.

Pass 5: Final Review: collected additional foods not remembered earlier. The computer screen listed a group of foods like candies and sweetened drinks for participants to check off.

Coding and analysis of dietary recalls

The PIPS (post interviewing processing system) extracted the data from the AMPM, assigned food codes where coding pathways have been established, and arranged the data into formats suitable for loading into Survey Net for final editing and review (123). A coding pathway led to a specific food code through the responses that were provided for the questions asked about a food. However, numerous coding pathways were responsible for coding within the AMPM that may seldom be used in an actual food recall, coding pathways were developed based

on data that were actually collected in the AMPM and coded using Survey Net. The USDA software Survey net was used to process the AMPM dietary recalls. Data from the USDA Food and Nutrient Database for Dietary Studies (FNDDS, 1.0 (2005)) was used to convert the portion sizes to grams and to determine the nutrient content of each food consumed (123).

The result of this computer program gave individual food and nutrients, daily total nutrients from foods and supplements. We also calculated the mean nutrient intakes and the percent of calories from protein, saturated fat, fat, carbohydrates, etc (119).

Case Studies

We also conducted informal case studies on 16 SA. We asked for volunteers to participate in these case studies. Of the 16 interviews total, we collected males and females from Pakistan, India, Bangladesh, and Other SA. The other group contained individuals from Sri Lanka, Nepal, Iran, and Afghanistan. The goal of the case studies was to get rich, in depth data on this population and to uncover patterns related to diet and shopping. The purpose of this analysis was to generate new information and to uncover dietary practices and related attitudes that would not be accounted for in the quantitative assessment methods. The data was organized into two groups. The first group had 8 interviews from those that lived in the U.S. for more than five years and the second group of 8 interviews was those that lived in the U.S. for less than 5 years (106, 124, 125). The differences may not be uncovered by the more structured questionnaires on diet intake i.e 24-hour recall. The notes were taken during the interviews. We were to discover complexities that exist in the cultural context of dietary practices. We visited the places where South Asians frequented, restaurants where they consumed foods, and shopping centers where they purchased foods.

Data Analysis Using SAS

Data preparation was performed using the Statistical Analysis Software (SAS) version 9.1 (SAS Institute Inc, Cary, NC). SAS was used to estimate descriptive and inferential statistics of interest and the associated variances.

Variables of Interest

The variables of interest are grouped together and placed into one of the following categories: Socio-demographic, medical history, household information, anthropometric, biochemical, clinical variables and dietary, and acculturation variables (Questionnaire shown in appendix A).

A. **Socio-demographic variables**

1. **Medical Record Extraction-** including age, gender, marital status, income, country of origin (India, Pakistan, Bangladesh, Iran, Sri Lanka, Nepal, Afghanistan), head of household, employment status (employed, retired, unemployed, unknown).

2. **Interview-** including age, gender, marital status, primary language, income, country of origin (India, Pakistan, Bangladesh, Iran, Sri Lanka, Nepal), years residing in U.S., education, type of housing (rent, own), head of household, English proficiency (proficient, somewhat proficient, limited, not proficient, unknown), employment status (employed, retired, unemployed, unknown, welfare) and physical activity (yes or no), days of week of exercise, minutes a day of exercise, what type of exercise (walking, running, jogging, weights, stretching, other), why do you exercise (look good, feel good, lose weight, doctor's orders, other) .

B. **Medical History**

1. **Medical Record Extraction**- variables include; current medications, previous illnesses/conditions, previous operations, smoking (current, past, never), drinking alcohol (frequently, occasionally, none), other drugs (yes, no), medication coverage (yes, no, unknown), insurance status (yes, no).

2. **Interview-** variables include: current medications, previous illnesses/conditions, previous operations, smoking (current, past, never), drinking alcohol (frequently, occasionally, none), other drugs (yes, no), medication coverage (yes, no, unknown), insurance status (yes, no).

C. **Household Information**

1. **Medical Record Abstraction**- variables include household size, number of children in household, annual household income

2. **Interview**- variables include household size, number of children in household and annual household income.

D. **Anthropometric variables**

1. **Medical Record Abstraction** - including **weight, height**. The participant's weight was measured on a digital scale with subjects wearing light street clothing with shoes removed. Weight was measured in pounds and height was measured in inches, on barefoot subjects with a fixed stadiometer with a vertical backboard and a movable headboard. Subjects were told to remove hair ornaments, buns and braids from the top of the head in order to measure stature properly. **Body Mass Index** (BMI) was calculated by dividing weight by squared height (Kg/m^2) and

categorized as; underweight (BMI<18.5), normal (18.5≤ BMI <20.9), overweight (21≤ BMI <22.9), obese (BMI ≥ 23.0) (24).

2. **Interview-** including **weight, height**, was measured (as stated above) and BMI calculated. **Body Mass Index (BMI)** was calculated by dividing weight by squared height (Kg/m^2) and categorized as; underweight (BMI<18.5), normal (18.5≤ BMI <20.9), overweight (21≤ BMI <22.9), obese (BMI ≥ 23.0). WC was measured at the high point of the iliac crest at minimal respiration to the nearest 0.1 cm at the end of normal expiration.

E. B**iochemical variables**

1. **Medical Record Abstraction - triglyceride (TG), total cholesterol (TC), HDL cholesterol (HDL-C), LDL cholesterol (LDL-C), total cholesterol/HDL ratio, fasting plasma glucose (FPG), red blood cell, hematocrit, hemoglobin AIC, blood and urea nitrogen.** Detailed description of laboratory methods is available from the Quest Diagnostics website in the Laboratory Procedures Manual (126).

2. **Interviews- (TG), (TC), (HDL-C), (LDL-C), (FPG, total cholesterol/HDL ratio, fasting plasma glucose (FPG),** was taken from the Quest lab report of each patient**.** Detailed description of laboratory methods is available from the Quest Diagnostics website in their Laboratory Procedures Manual (126).

F. **Clinical Variables -** included diastolic and systolic blood pressure measured by clinic personnel in mmHg.

G. **Dietary Variables –** from ASA24

1. **Medical Record Abstraction-** none

2. **Interviews** – collected by a 24-hour recall AMPM- variables included**:** Total kcal intake, grams of carbohydrates, total fats, proteins, saturated fats, and the percent of Kcals from carbohydrates, total fats, proteins, saturated fats, fiber, and HEI-2010 variables were calculated using the macros provided by the National Cancer Institute (127).

H. **Acculturation Variables**

1. **High Acculturation, Bicultural, Low-Acculturation.**

   Acculturation was measured using the SL-ASIA scale. The SL-ASIA scale is a 21-item multiple-choice questionnaire covering language (4 items), identity (4 items), friendship (4 items), behaviors (5 items), generation/geographic history/enclave residence (3 items), and attitudes (1 item). Results will be dichotomized as high acculturation and low acculturation based on scale scores, discussed above.

Statistical Analysis

Descriptive statistics was applied for all variables, including means and standard errors of the mean (SEM) for continuous variables and relative frequencies for categorical variables. The frequency distribution of each variable at baseline will be compared in men and women using the chi^2 test for categorical variables and t-test for continuous variables. The distribution of FPG, TG, HDL-C, SBP, DBP, BMI and WC will be examined graphically and if they are not normally distributed, the values will be log transformed. Before running the logistic regression model analyses, those variables with >10% missing data will be eliminated from the analysis. Separate

analyses will be performed for each gender stratified by ethnicity categories (Indian, Pakistani, Other (Bangladesh, Iran, Sri Lanka, Nepal)). Since non-Indian and Pakistani SA may not be available in significant numbers, we will combine these groups into a third category designated as "Other SA". All analyses were two-tailed and a $P < 0.05$ was considered statistically significant.

Chapter 4: Results

I. **Percent of Metabolic Syndrome Among Low Income South Asian Americans in Two Community Health Centers in Maryland**

ABSTRACT

Background: Cardiovascular disease (CVD) ranks first as the cause of death among adult Americans. Metabolic Syndrome (MetS) has been associated with an increased risk of CVD and type II diabetes (T2D), by as much as 3-fold in some studies. In South Asians (SA), MetS was likely responsible for significant morbidity, yet little is known about this population in the U.S. MetS is defined as a cluster of cardio-metabolic risk factors in the same individual.

Objective: We examined the percent of MetS and its defining abnormal indicators in SA attending 2 community health centers in Maryland. We compared measures of obesity (waist circumference (WC) and body mass index (BMI)) using ROC curves. We evaluated the appropriate gender specific WC cutoffs and BMI values for diagnosing central obesity in SA's. Gender specific MetS prevalence was evaluated by ethnic groups. We also used logistic regression to evaluate the greatest predictors of MetS for men and women.

Design: MetS was assessed in a cross-sectional study of 1401 SA adults from the South Asian American Health Initiative (SAAHI) utilizing community health centers in Maryland.

Results: The percentage of MetS in men and women was 47% and 54% respectively using the new consensus harmonized definition. The percentage of MetS differs depending upon which the obesity indicator was used (body mass index (BMI) vs. WC) and was highest in men using BMI (48% men vs. 47% women) and in women using WC measures (54% vs. 47%). ROC curve analysis also showed WC was a better obesity measure for SA women (Area under the curve =0.7575 for WC and Area under the curve =0.7166 for BMI) and for BMI was better (Area

under the curve=0.6796 for BMI and Area under the curve = 0.6518 for WC) for men. In measuring MetS, the new consensus definition recommendations for ethnic specific WC cut offs (90 cm in men and 80 cm in women were comparable to the WHO recommendations (BMI $\geq$23kg/m^2) for SA. It did not matter where BMI or WC were used as an obesity measure for diagnosing MetS, as long as the correct ethnic specific cut offs were used. MetS percentage varied by country of origin/ethnic groups: Indian 50%, Bengali 44%, Pakistani 43%, Other SA 41%. Overweight and obese subjects had higher percentage of MetS than normal weight subjects. The single greatest abnormal indicator was (HDLC, high density lipoprotein cholesterol), the two greatest clustered indicators were HDLC and triglycerides and the three greatest clustered indicators were HDLC, triglycerides and fasting blood glucose. The optimum WC cutoff for men was 89 cm and for women 79 cm.

Conclusion: This is the first study to enroll a large number and variety of low-income SA American immigrants. The percent of MetS (51%) in our sample of SA adults tends to be higher than the prevalence of MetS in African Americans, European Americans, and Mexican Americans yet little research has been done on this population. BMI and WC were comparable obesity measures for determining MetS as long as appropriate cut off values were utilized. SA females have greater percent of MetS (54%) compared to males (47%) using the recommended WC cut offs. SA Indians have a higher clustering of triglycerides and fasting blood glucose compared to Pakistani's, Bengali's, and Other SA's. HDL-cholesterol and triglycerides cluster together at the largest percent.

KEY WORDS: Metabolic Syndrome, South Asian Americans (SAA), low-income, immigrants, cardiovascular disease, type II diabetes, health disparities.

INTRODUCTION

CVD and T2D are leading causes of death in the USA, yet very little is known about the prevalence of MetS and its metabolic profile in SA. Studies show MetS is an important determinant of cardiovascular (CV) risk and present higher risks for CVD and T2D, and other related cardiovascular diseases(128). In the U.S., SA are one of the fastest growing minority population (129), however, there is very little data on health and disease profile of this population. MetS studies on the Asian subcontinent have shown that SA have increased risks compared to Americans (130). The prevalence of metabolic disorder risk factors have been increasing worldwide due to an alteration in lifestyle patterns such as increased caloric consumption coupled with reduction in physical activity that has become progressively more common with urbanization. For immigrant SA populations in the U.S., there is an added layer of complication due to the burdens associated with migration of individuals from other countries to the U.S. Wealthy and educated individuals in developing countries present obesity and related diseases differentially compared to wealthy and educated Americans. In the U.S., socioeconomically challenged population's present greater prevalence of obesity and related diseases, have less access to healthful foods, less physical activity outlets and generally less education related to health management. The physiological and metabolic changes that occur as a result of behavior patterns can be detected in primary care clinics by key MetS indicators. These indicators may prove to be strategic in identifying individuals at greater risk for chronic disease. This early determination is of particular importance in low-income individuals without health insurance because it can make a difference between trips to the emergency room.

The term 'MetS' was initially proposed following the determination that oxidative stress and inflammation coexist in the early phase of multiple risk factors including hypertension, dyslipidemia, diabetes, and obesity. MetS is a clustering of atherogenic metabolic abnormalities with different definitions promulgated by World Health Organization (WHO), National Cholesterol Education Program-Adult Treatment Panel III (NCEP-ATP-III) and International Diabetes Federation (IDF) in clinical practice. There has been a continued effort to improve the definition for MetS as well as the clinical utility of detection. Various diagnostic criteria have been proposed by different organizations over the past decade and most recently, several major organizations have come together for the development of a consensus definition of MetS recommended for use. In 2009, new harmonized definition guidelines required the presence of three or more of the following five components: i) abdominal obesity (waist circumference: men >90 cm, women >80 cm), ii) elevated triglycerides ($\geq$ 150 mg/dl) or use of medication, iii) low HDL-C (<40 mg/dl in men, <50 mg/dl in women) or use of medication , iv) elevated blood pressure (systolic or diastolic $\geq$ 130/85 mmHg or use of antihypertensive medication), and v) elevated fasting glucose (>100mg/dl), or use of antihypertensive medication, has been proposed despite controversy regarding its clinical usefulness and support by epidemiological studies (30). Traditionally, height and weight measures have been collected and therefore body mass index (BMI) has been easy to calculate. Height and weight measurements have been collected on a regular basis while waist circumference (WC) has only recently been consensually recommended by the new harmonized definition with ethnic specific cut offs.

Most of the disagreements about MetS have been related to measures and cut off values of obesity (WC and BMI). However, in SA, another point of contention is considering which one of the MetS indicators (WC or BMI) is more reflective of obesity in the development of metabolic

disease and what the cut off values for those indicators should be. Asians tend to have a higher percentage of body fatness at lower BMI and WC measures. The BMI cut-off levels for overweight and obesity in adults are based on the 5th and 95th centiles of body weight but the mortality profile are derived from the European American population (131). Dudeja showed a more accurate definition for Northern Indians based on the total amount of body fat with limits of fatness set at 30% for females and 25% for males. For Indians and European Americans, the appropriate BMI cut offs for obesity correspond to $21kg/m^2$ and $30kg/m^2$ respectively, using the same body fatness measures (131), which are even lower than the WHO recommendation $(BMI \geq 23kg/m^2)$.

Other MetS indicators also vary in degrees of importance where some studies on SA have pointed to fasting blood glucose while others have shown HDLC and triglycerides as being more suggestive of developing CVD and T2D (132). T2D and other metabolic diseases show greater prevalence in the SA population compared to other Americans including European Americans, African Americans, and Mexican Americans (10). The increased MetS risk presented also differs across gender, age, and ethnic populations (133). Studies in Asian Indians have shown mixed results with respect to gender and age compared to other populations. Khanna reported elevated risk factors at younger ages (133) while Prasad (134) showed increasing risk of higher ages.

Differences in percentage of body fat have been observed even in the same ethnic lineage residing in different geographical locations. One study traced the same ethnic lineage in three different populations of West African heritage from the U.S., Jamaica, and Nigeria. The relationship between BMI and body fat levels differed significantly (P<0.001) (135). Similarly, more is known about SA's residing in Asia and Europe, yet, very little about recent SA immigrants in the U.S. Furthermore, although the frequency of MetS in Indian patients has been

reported in previous population studies (94, 136, 137), few studies exist on MetS in Asians from other countries (Pakistan, Bangladesh, Sri Lanka, and Nepal) that represent South Asia, in the U.S. Additionally, the studies on SA Indians mentioned previously (91-93, 121) are not recent and more is known about other Americans (European, African, Mexican).

The purpose of this research was to examine the percentage of MetS in a convenience sample of SA in Maryland; To make comparisons of MetS using WC and BMI as body fatness measures; To determine the percent of SA study subjects with abnormal MetS indicators in 2 community health centers by gender; To describe differences and determine the percent of MetS among the Asian ethnic groups (defined by country of origin (CO)); To determine the most predictive (of MetS) gender specific WC and BMI measures for obesity; and to use logistic regression analysis to make associations in the development of MetS.

SUBJECTS AND METHODS

Subjects: SAAHI began in May 2012 as a health study for SA in Maryland. We examined 1401 men and women between ages 20-68 years from Pakistan, India, Bangladesh, Sri Lanka, Iran, Afghanistan, and Nepal. A systematic sample of subjects was obtained from two religious community centers in Montgomery and Baltimore County, Maryland.

Systematic Sampling of Clinical Files: We randomly selected the first file and then collected data from every 2nd file thereafter. This resulted in a sample of 1001 subjects who met our inclusion criteria. Systematic sampling was used by sampling every k^{th} item in a population. The sample size (n =1000) was chosen based on the power calculation. We used the following formula for systematic sampling: $K \leq N/n$. In the Montgomery County clinic we selected every 2nd file while from Baltimore County clinic we collected a convenience sample of consecutive walk-ins.

Interviewed Sample: We interviewed a convenience sample of volunteer walk-ins (N=401) from the same two clinics to obtain WC, not available from the clinic files. All patients gave informed consent before participation in the study and study protocol was approved by the Institutional Review Board of University of Maryland and also by the review boards of the two community centers. On the subjects that we interviewed (n = 401), we obtained WC and used the new ethnic specific cut off values ($\geq$90cm in males, $\geq$80cm in females) (9) mentioned above. WC was measured at the high point of the iliac crest at minimal respiration to the nearest 0.1 cm at the end of normal expiration. The participant's weight and height were measured on a detecto's promed 6129, (Thornton, CO) scale with subjects wearing light street clothing with shoes removed.

Assessment of MetS: The diagnosis of MetS was based on the new harmonized definition (9) guidelines and required the presence of three or more of the following five components: i) abdominal obesity (waist circumference cut offs for South Asians: men ≥90 cm, women ≥80cm), ii) elevated triglycerides (≥ 150 mg/dl or statins use) or use of medication, iii) low HDL-C (<40 mg/dl in men, <50 mg/dl in women) or use of medication, iv) elevated blood pressure (systolic or diastolic ≥ 130/85 mmHg or use of antihypertensive medication), and v) elevated fasting glucose (>100mg/dl or hypoglycemic agents). We used a modified harmonized definition for 1001 individuals. BMI was calculated by dividing weight by squared height (Kg/m^2) and categorized as; underweight ($BMI<18.5$ Kg/m^2), normal (18.5 $Kg/m^2 \leq BMI < 20.9$ Kg/m^2), overweight (21 $Kg/m^2 \leq BMI < 22.9$ Kg/m^2), obese ($BMI \geq 23.0$ Kg/m^2) as recommend for SA by WHO (24). Subjects were told to remove hair ornaments and buns from the top of the head in order to measure stature properly.

Statistical Analysis: A power calculation was performed based on the overall prevalence of MetS in the SA population (27%) (3), which resulted in 400 subjects with a reasonable minimum effect of $\alpha = 0.05$, a minimum power to detect that effect, and the sample size that would achieve that desired level of power was 80%. Power calculations for each individual MetS indicator revealed that we needed a sample size of at least 920 to compare triglycerides levels, so we rounded up to 1000. All data were analyzed using SAS 9.2 statistical software (SAS Institute, Cary, NC). Data were expressed as mean ± SD; student t-test was used to compare means between groups, and chi-square test to compare proportions between groups. We used ANOVA from GLM with Sheffe adjustment for multiple unequal comparisons. $P < 0.05$ was considered statistically significant to compare the characteristics of MetS indicators between the four groups. A logistic regression was used to evaluate the associations between presences of MetS

and exercise, years in the U.S, years in school, income, and country of origin. Age and sex were covariates. Receiver Operating Characteristic (ROC) curve analysis was used to determine the appropriate gender specific WC cutoffs that predict the presence of two or more risk factors of MetS including, hypertriglyceridemia, hyperglycemia, hypertension, and low HDL cholesterol. Using logistic regression analysis and plotting sensitivity vs. 1-specificity, we investigated how accurately WC could predict the presence of two or more MetS factors. Perfect prediction using WC would have a point on the ROC curve with 100% sensitivity and specificity. The distance on ROC curve for WC values from perfect predictor was calculated. To determine the optimal thresholds, the point on the ROC curve with maximum Youden Index [sensitivity-(1-specificity)], and the point with shortest distance value from the point (0,1) [(1-sensitivity)^2+(1-specificity)^2 were calculated (138). These are the two most commonly used methods for establishing the optimal cut-off (138).

RESULTS

We studied 1401 South Asian immigrants to the United States. The sample consisted of males 47% (N=611) and females 53% (N=742) who attended two religious community centers in Silver Spring and Baltimore, in MD. The SA countries represented in our sample included: India 17%, Pakistan 54%, Bangladesh 16%, Nepal 4%, Sri Lanka 2%, Afghanistan 2%, and Iran 3%. We divided the sample into four subgroups comprised of Pakistani, Indian, Bengali, due to small sample sizes we grouped the remaining nationalities into a category called "Other SA".

The mean ages of males and females were similar, 48±11 years old. All of the subjects were uninsured and 15% had no education, while 54% were at least high school educated. A total of 27% had a bachelor degree and 13% had graduate level education. A small portion (9.5%) attended school in the U.S. while the remaining attended school in their respective countries of origin: Pakistan 51.1%, India 14.2%, Sri Lanka 2.7%, Bangladesh 14.0%, Nepal 4.7%, Afghanistan 1.3%, and the remaining 6 countries reported were less than 1%. The average years of completed school were 11.9 years with a range of 0 -24 years.

The majority of the sample reported being married 76.3% (N=305) and lived with a spouse 74.5% or significant other and reported an income of $30,000 or less. The average number of years residing in the U.S. was 10.9±8.8 years. The average number of children was 2.2 with a range of 0-8 children.

On the interview day, subjects were asked the reason for their visit. They reported the following reasons (from most prevalent to least) : Other (46.4%) because they are either sick or they do not want to share the reason, follow-up visit (27.3%), regular yearly visit (17.8%), and check-up for an existing condition (8.7%). The frequency of all medication use in SA was 56.9%. More than half of the interviewed subjects reported being employed (53.1%), while

(46.9%) were unemployed. The top five types of employment were limo/cab driver at 6.5%, self-employed 4.1%, child care 3.8%, clothing store 3.3%, and gas station 3.0% and less than half were homeowners (31.9 %). Traditional clothing was worn sometimes by 77.7% some of the time while 29.4% wore traditional clothing all the time. About 18.0% wear traditional clothing at home and 23.5% for gatherings and attending places of worship.

The mean height and weight were 64.1in.±3.8 and 162.5lb.±33.0, respectively. The mean BMI was 24±5 for males and 28 ± 6 kg/m^2 for females. Overall, 71% of the subjects were overweight and obese. Normal weight subjects comprised of 27.4% of the sample, 40.0% were overweight, 31.1% were obese, and 1.4% were underweight (BMI≤ 18.5 kg/m^2). There were too few underweight subjects for a meaningful analysis (n=11). **Table 1** shows the mean ± SD of lipid and blood pressure values for the entire sample (n=1401) and separated by gender.

The religions of the sample subjects included: Islam 77.8%, Christianity 8.2%, Hinduism 8.5%, Sikh 3.0%, Buddhism 1.8%, and other religions reported at 1%. There were 17 languages reported among those interviewed and many people spoke more than one language. The top three languages spoken were Urdu 36.2%, Panjabi 19.5%, and Bengali 14.2%.

Breakdown by gender: Males and females had the same average age in this sample 48.7±11 and 48.8±12. They also had the similar reported marital status, males 78% and females 79% were married. Education status varied significantly, 20% of females and 7% of males had no education. 56% of males and 43% of females attained their high school degree. A greater percentage of males had a bachelor and graduate degrees (39%) males and (19%) females and (19%) males compared to females (8%) respectively. All mean values of clinical variables in **Table 1** were significantly different for males and females except for WC.

Interviewed Subsample: From the total 401 interviewed sample participants: 190 were males 211 females. The top three countries represented in this subsample, Pakistan 57.4%, India 16.2%, and from Bangladesh 15.2%. The remaining subjects were from Sri Lanka, Afghanistan, Iran, and Nepal. The average age was 47±13 yrs., height 64±4 in., weight 164±34 lbs., BMI 28±5 kg/m^2, WC 96 ± 12 cm. From the 401 people interviewed, 56% reported that they exercise while 44% do not. The average days of exercise is 2 with a range of 0-7 days, and the average minutes are 22 with a range of 0-240 minutes (**Table 2**). Average years in school was 12±4 yr., average years in U.S 11±9 yr.

Breakdown by gender for Interviewed Subsample: The average WC was not statistically different for males 97 ± 12 cm (n=190) and females 96 ± 13 cm. (n=211) (**Table 2**). Age and BMI were also not statistically different (**Table 2**). Males and females had the same average number of days (2±2) of exercise and the minutes of exercise for males (24±32) and females (20±28) were not significantly different. Males were significantly taller on average 66±3 in. compared to females 62±3 in. (P<0.001) and significantly heavier 173±34 lbs. and 156±31 lbs. as well (P<0.001). Males had spent a significantly longer time on average in the U.S. 12±9 yrs. compared to females 10±9 yrs., and more years in school on average 13±4 yrs. vs. 11±5 yrs. (P=0.0201). Comparing the clinical values in males and females, there were significant differences for HDLC, triglycerides, and fasting blood glucose (**Table 2**). Males had higher values for triglycerides (171±124 mg/dL) and fasting blood glucose (119±61 mg/dL) compared to females (141±80 mg/dL) and (106±38 mg/dL) respectively and lower values for high density lipoprotein cholesterol (HDLC) 43±13 mg/dL vs. 49±15 mg/dL.

Breakdown by Country of Origin: The majority of the sample were from Pakistan 53% (n=761). The remaining countries were India 17.7% (n=245), Bangladesh at 16.0% (n=224), and

57

the Other SA 12.2% (n=171). Bengali subjects had the lowest education level (18.3% had a high

school diploma), while Indians were the most educated. Indians have the largest number of

subjects that completed graduate school (14.9%), followed by Bengali (13.6%), Other SA

(10.6%), and Pakistani (9.8%). Indians also had the largest sample completing a bachelor degree

(28.9%), while Pakistani's had the greatest number completing high school (41.9%).

Most of the ethnic groups were homogeneous in marriage and divorce percentages. A

majority of all the ethnic groups were married and or living with a partner: Pakistan group,

81.1% (N=708) were married living with a partner and 19.0% single or divorced, Indians 73.7%

(N=232) were married living with a partner and 26.3% single or divorced, Bengali have 75.7%

married or living with a partner with 24.3% single or divorced, and the Other SA had 77.1%

married with 22.8% single or divorced.

The percent of obesity calculated by BMI groups (normal, overweight, obese) differed by

ethnic groups. Pakistani's had the highest percentage of obesity (36.4%) followed by Other SA

(28.9%), Bengali (15.0%), and Indian (5.4%). The percentage of overweight subjects in

descending order include: Bengali (41.8%), Pakistani (40%), Other SA (39.8%), and Indian

(39%). The percent of obesity in the Bengali population was not as much as in Pakistani and

Indian. The association between BMI status and ethnicity was significant (p <0.001).

Breakdown by gender and Country of Origin: Our results using showed that the associations

for triglycerides, fasting blood glucose, diastolic blood pressure, between the ethnic groups were

not significant by ethnic group. The only significant differences that existed were between

Bengali and Other SA females were abnormal HDLC values (below 50 mg/dL). Differences

between systolic blood pressure between the ethnic groups in males (significant at p <0.05) and

females were not significant. The systolic blood pressure values of males and females were

significantly different (P<0.05) and males had significantly higher values than females after adjusting for age. In the interviewed subsample, (**Table 2**) the majority of the sample were from Pakistan 57.5% (n=230), then India 18.5% (n=74), Bangladesh 13.8%, (n=55) and Other SA 10.3% (n=41).

MetS Prevalence and Indicators: According to the definition of MetS, being positive for three of the five indicators constitutes having MetS. The overall percent of MetS was 51%. The overall percent of MetS using the modified definition using BMI for obesity measure ($\geq$23 kg/m^2) was 48% (**Table 3**). We also compared the IDF WC recommendation (cut off 102cm for males, and 88 cm for females) for European Americans on SA and found the percent of MetS at 44% and the other BMI cut offs (25 kg/m^2 and 30 kg/m^2) at 48% and 42% respectively (**Table 3**).

The most common abnormal MetS indicator and a combination of 2, 3, and 4 indicators was shown in **Table 4**. The most often occurring abnormal indicator in the SA population was HDLC. The combination of the two most prevalent indicators were HDLC and triglycerides, and the clustering of the three most prevalent were HDLC, triglycerides, and fasting blood glucose. SA Indians presented differential clustering compared to the other ethnic groups where triglycerides and fasting blood glucose were more prevalent.

Ethnic groups presented the percentage of MetS differently. In Pakistani's, the percentage of MetS using BMI ($\geq$ 23 kg/m^2) was 51% and using WC was 49%. The percentage in Indians using BMI was 46% and using WC was 54%. The percentage of MetS for Bengali using BMI was 48% and using WC was 51%. The percentage of MetS in Other SA using BMI was 38% and using WC was 44%.

Breakdown by Gender: Females had a greater percent of MetS (54%) compared to males (47%) using WC as a MetS obesity measure. Among the Pakistani group females have a greater

percent of MetS using WC compared to males 52% versus 49%. Using BMI ($\geq$ 23 kg/m^2) males

have an greater percent of MetS 50% vs. 49% using the WHO recommended cut offs

($\geq$23kg/m^2). Males in the Indian group had a greater percent of MetS (48%) compared to Indian

females (46%) using BMI, and Indian females had a greater percent using WC measures

compared to Indian males (49%) and (46%) which may indicate abdominal obesity was more

highly associated with acquiring disease in women.

Within the Bengali group, males have a lower percent for MetS (50%) compared to females

(62%) using both WC and BMI measures (53% and 45%) respectively.

Within the Other SA group males have a greater percent of MetS using BMI (40%)

compared to females (37%) and a lower percent of MetS using WC (56%) compared to males

(25%) for obesity.

Addressing MetS Predictors: We used logistic regression analysis association between the

determinants for those who have MetS compared to those who do not. We found only age to be

statistically significant for males in predicting MetS (P<0.05). MetS increased as age increased

for males. The remaining variables were not significant (years in the U.S, minutes of exercise,

salary, and education). For females, MetS increased with age and decreased with minutes of

exercise (P<0.05).

ROC Curve Analysis: Comparison of gender specific ROC curves for BMI and WC resulted in

a better curve for WC in women; area under the curve was 0.77 with confidence limits of (0.003

to 0.003). BMI yielded a better curve for men (area under the curve 0.68 with confidence limits

(0.003 to 0.005).

The analysis suggested that yielding at least 80% sensitivity, the WC value of 88 cm for

men and 79 cm for women in predicting the presence of two or more MetS risk factors for SA's.

Based on these cutoffs, there is an increase in the prevalence of central obesity and in the age adjusted prevalence of MetS. The metabolic syndrome was more common in women compared to men and increased slightly for men with lower than recommend WC measures (48% for men and 54% for women).

Discussion

The best available evidence suggests that people with MetS are at increased risk of cardiovascular events (139). There is a wealth of information on Mets in European Americans, African Americans and Mexican Americans collected by the NHANES but SA in the U.S. are still largely under studied. Recently, the NHANES added an Asian sample including all of East and South Asians together. Studies show there are enough differences between East and South Asians to separate them when studying their health and disease status. Additionally, the numbers of studies on SA alone are few in the U.S and most of these are on Indians. To our knowledge this is the largest and most diverse cohort (India N=245, Pakistan N=761, Bangladesh N=224, Sri Lanka N=31, Nepal N= 62, Iran N=49, and Afghanistan N=25) of SA (742 women and 661 men) and the one of the largest (N=1403) studies defining MetS on SA subjects in the U.S. This study contains a large number of subjects from South Asian countries, other than India, such as Bangladesh N=224 and Pakistan (N=761), in the U.S.

The harmonized definition is the most recent agreed upon definition of MetS by several organizations including the IDF, NCEP ATP, and WHO (30). Our data show the percentage of MetS using the WC cut off recommended for SA is 51% and this was most comparable to the BMI cut off point recommended by the WHO set at ≥ 23 kg/m^2 for overweight in SA (Mets of 49%). Using the recommended harmonized criteria (16) SA had a higher percentage (48%) than European Americans (21.8%), African Americans (22.7%), and Mexican Americans (31.9%) in the U.S. Previous studies have not used the latest consensus definition.

The South Asian Health Center study (SAHC) in California N=1445 (3) cohort (1012 men, 433 women) found the percent of Mets at 27% with a majority of the sample's birth country being from India N= 749 (Pakistan N= 9, Sri Lanka N=5, U.S. N=40). Their recruitment effort

was through a nonprofit organization (SAHC) program at El Camino Hospital (30). They used the previous NCEP ATP III definition with BMI cut off values of 25.0-29.99 kg/m^2 for overweight and ≥30.0 kg/m^2 for obesity. The percent of MetS in our study was higher when using the NCEP ATP III criteria BMI (≥25 kg/m^2) at 48%, and for BMI (≥30 kg/m^2) it was 42%.

The percent of MetS found in our study was also greater than that found in the 2004 New York City Hanes (NYCHANES) study. Our results showed the percent of MetS in our sample of Asian Indians to be 45% while their results revealed a rate of 13.3% among Asian Indians and 12.0% among the All Asians category that includes South and East Asians (140). However, the All Asians category was lower than Asian Indians. In the NYCHANES, the average age of SA were 42.2, 34.5% had income <20K/yr., 94.6% were foreign born, and 30.4% were uninsured out of the total sample size of 160 Asians. However, our sample had a greater percentage (78%) that made less than $30K/yr., 95% were from their host countries, and all of them were uninsured. It may be that socioeconomic differences exemplified through the low income subjects and lack of insurance in our study and the higher income with 69% insured NYCHANES contributed to the increased prevalence of MetS in our study.

In 2011, Dodani conducted a community based cross-sectional study to ascertain the prevalence of MetS in South Asian immigrants in Kansas to examine the association between MetS and HDLC function, Apo lipoprotein (APO1) gene polymorphisms, and sub-clinical CAD using common carotid intima-media thickness as a surrogate marker. The sample contained 35-65 yr. old adults (76 males, 53 females) from Georgia, Kansas, and Missouri. That study used Hindu temples as recruitment site with a total sample size of 129 with complete information on first generation South Asian Indians (SAI). The subjects were categorized into various language groups (South Asian N=33, Guajarati N=23, Hindi N=23, Bengali N=10, Punjabi N=8, Other

N=4). Using the IDF definition they found the MetS percentage at 29.7% in SA immigrants without CAD. In this same study, the percent of MetS was 13.3% using the WHO definition and 40% using NCEP ATP III definition which was similar to our study. Most importantly they found that 26% had HDL inflammatory index suggesting pro-inflammatory dysfunctional HDLC (132). Their study showed an association between low HDLC levels and APO A-1 gene (G5:C938T). The single nucleotide polymorphism (SNP) was found to be significant in other SA studies as well (141). Our study subject also had a high percentage of abnormal HDLC levels and Table 4 showed that it was the most prevalent abnormal indicator.

MetS was significantly associated with BMI $\geq$ 23 kg/m^2 and 3 Apo A-1 SNP's (G2, G3, and G5). Dodani also found that SA Indians have high T2D (17%) prevalence despite low body weight. Dodani suggested that SA have a different metabolic profile compared to other European Americans, African Americans and Mexican Americans.

In our sample, **Table 3** shows that women had a higher percentage of MetS (55%) than men (47%) but the results were different from those of Flowers, et al. (3) who found that males had a greater percentage using the same MetS criteria. Flowers (10) suggests that estrogen levels were protective for females but we did not find that in our study. The comparison between males and female WC measures were not statistically different (**Table 1**) but women had a higher percentage of abnormal WC measures (**Table 7)** and the association between abnormal WC values and sex was statistically significant at (p <0.001).

The gender differences were confirmed by our analysis using the ROC curve comparing BMI and WC as measures in predicting the presence of two more MetS risk factors. The ROC analysis also suggested similar WC cutoff for men (90 cm to 89cm) and women (80 cm to 79cm)

from the current recommendations. This increased the percentage of Mets in men from 47% to 48% while women were not affected.

Overall, Indians had the highest percentage of MetS 54% compared to Bengali 51%, Pakistani 49%, or Other SA 44%. That was because Indian females had a percentage of 62%. Indian females clustered two MetS indicators differently compared to the other ethnic groups, showing the highest clustering for abnormal fasting blood glucose and HDLC. Indian females did not have significantly different ages, education levels or reported salaries. The number of year's residence in U.S for Indian females was highest and the mean WC was higher than the other ethnic groups suggesting possible increased adoption of western eating habits. Comparisons of females using BMI categories showed that overweight Indian females had a higher MetS (52%) compared to other overweight females (50%). Obese Pakistani females had the highest MetS at 62%. It may be that metabolic abnormalities are detrimental at lower body fatness measures for Indians compared to other ethnic groups as suggested in other studies of Asian Indians (1) even though Pakistani and Indians are SA. It may be that impaired fasting blood glucose is more detrimental in the development of MetS compared to HDLC and triglycerides for Asian Indians at lower BMI.

Bengali males had the highest MetS (50%) while the Other SA group men had the lowest (25%). Meaningful comparisons for the Other SA group may be difficult due to small sample size (N=16). Bengali males had significantly more education compared to Pakistani and they also had significantly lower average BMI (25.9 kg/m^2) compared to Pakistani and Indian and lower WC compared to Pakistani and Indians. Bengali men had the greatest number of people in the highest salary bracket earning between $45K-60K. This was surprising since we expect those with higher education levels and lower BMI levels to be less susceptible towards disease.

Interestingly, Bengali males also had the lowest number of years in the U.S. suggesting that they still present disease as they would in their respective countries where it may be possible that more wealth equates to money for more food. Their clustering of MetS indicators is highest for triglycerides and HDLC which may be indicative of a high fat diet in the absence of obesity.

Pakistani men had the highest obesity at 61% and we expected to calculate the highest percent of MetS among this group. It may be that obesity is probably not the most important factor in the development of MetS, otherwise we would expect to see the highest percent of MetS among the obese Pakistani men. When we examined the difference between BMI and WC we saw that both of the measures of obesity could be comparable in the acquisition of MetS which has been suggested in some studies as long as the correct (BMI ≤ 23 kg/m^2 and WC ≤ 90 cm) values are being applied to the subjects.

Obesity measured by BMI among the SA was higher (31.7%) than European Whites (23.7%) and Hispanic Americans (28.7%), but lower than African Americans (35.7%). SA males have the highest prevalence of obesity (34.5%) compared to European Whites (25.4%), Hispanic Americans (27.8%), and African Americans (31.6%). SA females have a higher prevalence of obesity (35%) compared to European Whites (21.8%) and Hispanic Americans (29.4%) but not African Americans (39.2%). As expected, the trend of increased BMI as subjects aged was evident. Obesity increased with age in our sample and was greater among ages ≥ 60 yrs. (45%) compared to subjects between 18-65 years (31%) but there was a greater percentage of overweight subjects (40%) in 18-65 yr. age group compared to older subjects (≥ 60 yrs.) at 24%.

Older males and females (≥ 60 yrs.) had a greater percent of MetS 64% and 82% respectively, compared to younger males and females (18-65yrs.) at 50% and 44%. The association between MetS and age was statistically significant only for females (p<0.005). It may

be that obesity is a greater factor for women compared to men since MetS was also higher in females using the WC measure to calculate obesity instead of BMI.

We also calculated the highest prevalence of 2, 3, and 4 abnormal indicators. **Table 4** shows that HDLC was the highest abnormal indicator in SA. The two most prevalent abnormal MetS indicators were HDLC and triglycerides (29.4%) and the three most prevalent indicators were HDLC, triglycerides, and fasting blood glucose (17.8%). The 4 most prevalent abnormal indicators were HDLC, triglycerides, fasting blood glucose, and BMI. These results were similar to other SA studies (3, 142, 143) showing a clustering of abnormal lipid profiles with MetS. Other studies suggested the common patterning of SA with insulin resistance in addition to dyslipidemia characterized by the presence of high triglycerides and small dense dysfunctional HDLC (132). The most debated indicators have been BMI and WC but the most prevalent abnormal indicators in SA's were triglycerides and HDLC (**Table 4**) followed by fasting blood glucose.

As age increased, MetS increased (P<0.05) and it was the only statistically significant variable for males in determining MetS. For females, age and exercise were statistically significant at (p<0.001). Increasing age and decreasing exercise increased MetS. Education, years in the U.S., and country of origin were not associated with the probability of developing MetS.

Our results show that (**Table 5**) the best WC cut offs for SA men and women are 89 cm and 79 cm respectively. These cut offs are similar to those promulgated in the harmonized definition (9). We believe these WC cutoffs are more appropriate because physicians can screen and treat patients at risk for metabolic disorders, which would otherwise be misdiagnosed if they used a different cut off.

Conclusion

The prevalence of MetS (51%) in SA adults tends to be higher than in African Americans, European Americans, and Mexican Americans. SA females have greater prevalence of MetS (52%) compared to males (47%) using the recommended (≤ 90 cm for males, ≤ 80 cm for females) WC cut offs. Slight reduction in the WC cutoffs 89 cm for men and 79 cm for women will increase the prevalence of Mets in men. Indians have a greater prevalence of MetS (50%) compared to other ethnic groups with Indian females having the highest prevalence (62%). Most of research in the U.S. on SA's has been focused on Asian Indians and our research indicated that the Indian ethnic group had a differential abnormal indicators. The most prevalent abnormal indicators were HDLC and triglycerides followed by high fasting blood glucose for all SA except Asian Indians. For Asian Indians HDLC and fasting blood glucose levels had a higher abnormal percentage. SA also have more abnormal MetS indicators at lower BMI levels, overweight (39.8%) compared to obese (31.3%). Further evaluation is needed to find cultural and socio-demographic patterns that affect immigrant SA populations. It may be that cultural barriers and dietary patterns play a crucial role in the development of abnormal MetS indicators and increase the prevalence of MetS.

References

1. Ram CVS, Farmer JA. Metabolic syndrome in South Asians. Journal Of Clinical Hypertension (Greenwich, Conn) 2012;14(8):561-5. doi: 10.1111/j.1751-7176.2012.00652.x.
2. Jordan HT, Tabaei BP, Nash D, Angell SY, Chamany S, Kerker B. Metabolic syndrome among adults in New York City, 2004 New York City Health and Nutrition Examination Survey. Preventing Chronic Disease 2012;9:E04-E.
3. Gupta R, Deedwania PC, Gupta A, Rastogi S, Panwar RB, Kothari K. Prevalence of metabolic syndrome in an Indian urban population. International Journal Of Cardiology 2004;97(2):257-61. doi: 10.1016/j.ijcard.2003.11.003.
4. Alberti KGMM, Eckel RH, Grundy SM, et al. Harmonizing the Metabolic Syndrome. Circulation 2009;120(16):1640-5.
5. Dudeja V, Misra A, Pandey RM, Devina G, Kumar G, Vikram NK. BMI does not accurately predict overweight in Asian Indians in northern India. The British Journal Of Nutrition 2001;86(1):105-12.
6. Dodani S, Henkhaus R, Wick J, et al. Metabolic syndrome in South Asian immigrants: more than low HDL requiring aggressive management. Lipids In Health And Disease 2011;10:45-. doi: 10.1186/1476-511X-10-45.
7. Alberti KGMM, Zimmet P, Shaw J. Metabolic syndrome—a new world-wide definition. A Consensus Statement from the International Diabetes Federation. Diabetic Medicine 2006;23(5):469-80.
8. Khanna R, Kapoor A, Kumar S, Tewari S, Garg N, Goel PK. Metabolic syndrome & Framingham Risk Score: observations from a coronary angiographic study in Indian patients. The Indian Journal Of Medical Research 2013;137(2):295-301.
9. Prasad DS, Kabir Z, Dash AK, Das BC. Prevalence and risk factors for metabolic syndrome in Asian Indians: A community study from urban Eastern India. Journal Of Cardiovascular Disease and Research 2012;3(3):204-11. doi: 10.4103/0975-3583.98895.
10. Luke A, Durazo-Arvizu R, Rotimi C, et al. Relation between Body Mass Index and Body Fat in Black Population Samples from Nigeria, Jamaica, and the United States. American Journal of Epidemiology 1997;145(7):620-8.
11. Deepa M, Farooq S, Datta M, Deepa R, Mohan V. Prevalence of metabolic syndrome using WHO, ATPIII and IDF definitions in Asian Indians: the Chennai Urban Rural Epidemiology Study (CURES-34). Diabetes/Metabolism Research and Reviews 2007;23(2):127-34. doi: 10.1002/dmrr.658.
12. Mohan V, Shanthirani S, Deepa R, Premalatha G, Sastry NG, Saroja R. Intra-urban differences in the prevalence of the metabolic syndrome in southern India -- the Chennai Urban Population Study (CUPS No. 4). Diabetic Medicine: A Journal Of The British Diabetic Association 2001;18(4):280-7.
13. Sandeep S, Gokulakrishnan K, Deepa M, Mohan V. Insulin resistance is associated with increased cardiovascular risk in Asian Indians with normal glucose tolerance--the Chennai

Urban Rural Epidemiology Study (CURES-66). The Journal Of The Association Of Physicians Of India 2011;59:480-4.

14. Misra A, Misra R, Wijesuriya M, Banerjee D. The metabolic syndrome in South Asians: continuing escalation & possible solutions. The Indian Journal Of Medical Research 2007;125(3):345-54.

15. Misra A, Khurana L. Obesity and the metabolic syndrome in developing countries. The Journal Of Clinical Endocrinology And Metabolism 2008;93(11 Suppl 1):S9-S30.

16. Misra A, Khurana L. The metabolic syndrome in South Asians: epidemiology, determinants, and prevention. Metabolic Syndrome And Related Disorders 2009;7(6):497-514.

17. Misra R, Patel T, Kotha P, et al. Prevalence of diabetes, metabolic syndrome, and cardiovascular risk factors in US Asian Indians: results from a national study. Journal Of Diabetes And Its Complications 2010;24(3):145-53.

18. Alberti KGMM, Eckel RH, Grundy SM, et al. Harmonizing the Metabolic Syndrome: A Joint Interim Statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. Circulation 2009;120(16):1640-5.

19. Alberti KG, Zimmet PZ. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus provisional report of a WHO consultation. Diabetic Medicine: A Journal Of The British Diabetic Association 1998;15(7):539-53.

20. Flowers E, Molina C, Mathur A, et al. Prevalence of metabolic syndrome in South Asians residing in the United States. Metabolic Syndrome And Related Disorders 2010;8(5):417-23.

21. Schisterman EF, Perkins NJ, Liu A, Bondell H. Optimal cut-point and its corresponding Youden Index to discriminate individuals using pooled blood samples. Epidemiology (Cambridge, Mass) 2005;16(1):73-81.

22. Eckel RH, Alberti K, Grundy SM, Zimmet PZ. The metabolic syndrome. The Lancet;375(9710):181-3. doi: http://dx.doi.org/10.1016/S0140-6736(09)61794-3.

23. Rajpathak SN, Gupta LS, Waddell EN, et al. Elevated risk of type 2 diabetes and metabolic syndrome among Asians and south Asians: results from the 2004 New York City HANES. Ethn Dis 2010;20(3):225-30.

24. Dodani S, Dong Y, Zhu H, George V. Can novel Apo A-I polymorphisms be responsible for low HDL in South Asian immigrants? Indian Journal Of Human Genetics 2008;14(1):9-15. doi: 10.4103/0971-6866.42321.

25. Misra A, Khurana L, Isharwal S, Bhardwaj S. South Asian diets and insulin resistance. British Journal of Nutrition 2009;101(4):465-73. doi: 10.1017/s0007114508073649.

26. Singh GK, Miller BA. Health, life expectancy, and mortality patterns among immigrant populations in the United States. Canadian Journal Of Public Health Revue Canadienne De Santé Publique 2004;95(3):I14-I21.

27. Gupta M, Doobay AV, Singh N, et al. Risk factors, hospital management and outcomes after acute myocardial infarction in South Asian Canadians and matched control subjects. Canadian Medical Association Journal 2002;166(6):717-22.

TABLES

TABLE 1: Demographic and Clinical Characteristics of US South Asian Adults by gender Two Community Health Centers in Maryland

Characteristic	Mean±SEM or %(N)	Men (n=661) or %(N)	Women (n=742)
Age (yrs.)	48±11	48±11	48±12
Height (cm)		67±3*	62±3*
Weight (lbs.)		173±33*	153±32*
BMI $^\epsilon$ (kg/m^2)	28±5	24±5$^\lambda$	28±6$^\lambda$
Ethnic Origin			
Pakistan	53(761)	56(373)	52(388)
India	18 (245)	17(110)	18(135)
Bangladesh	16(224)	17(110)	15(114)
Other SA	12 (171)	10(68)	14(103)
Married	78 (1032)	47(488)	53(544)
Education			
None	13(141)	19(27)	81(114)
Elementary	10(104)	27(28)	73(76)
High School	39(417)	48(199)	52(218)
Bachelor	25(265)	59(157)	41(108)
Graduate	11(121)	63(76)	37(45)
Clinical Variables			
HDLC $^\epsilon$ (mg/dL)	46±13	42±11*	49(14)*
Triglycerides (mg/dL)	160±110	180±130*	141(85)*
Blood glucose (mg/dL)	113±52	119±63*	108(39)*
Systolic BP $^\epsilon$ (mmHg)	124±20	125±17*	123±20*
Diastolic BP $^\epsilon$ (mmHg)	77±11	79±11*	76±12*

*P<0.001, λ P=0.0062, $^\epsilon$ BMI: body mass index, HDLC: high density lipoprotein cholesterol, BP: blood pressure

TABLE 2: Background Demographic and Clinical Characteristics of the Interviewed Sample by Gender

VARIABLE (401)	AVE. ± SEM	MALE (191)	FEMALE (210)	P VALUE
Age (yrs)	47±13	48±12	46±13	0.4097
Height (cm)	64±4	66±3	62±3	<0.001
Weight (lbs)	164±34	173±34	156±31	<0.001
BMI* (kg/m^2)	28±5	28±5	29±5	0.9282
WC* (cm)	96±12	97±12	96±13	0.6465
Years in School (yrs)	12±4	13±4	11±5	<0.001
Years in U.S. (yrs)	11±9	12±9	10±9	0.0201
Days of Exercise	2±2	2±2	2±3	0.3926
Minutes of Exercise	22±13	24±32	20±28	0.2861
Clinical Variables				
HDLC* (mg/dL)	47±14	43±13	49±15	<0.001
Triglycerides (mg/dL)	155±105	171±124	141±80	0.0044
Blood glucose (mg/dL)	112±50	119±61	106±38	0.0130
Systolic BP* (mmHg)	122±17	123±15	121±19	0.2072
Diastolic BP* (mmHg)	77±11	78±11	76±11	0.0844

*BMI: body mass index, WC: waist circumference, HDLC: high density lipoprotein cholesterol, BP: blood pressure

TABLE 3: Percent of MetS* among US SAA* by gender using BMI* cut off for the whole sample and WC* cut off for interviewed sample only

Whole Sample	BMI category (kg/m2)			Interviewed sample only	WC category (cm)	
	@23Kg/m^2 %(n)	ω25Kg/m^2 %(n)	β 30 Kg/m^2 %(n)		^102cm M 88cm F % N	#90cmM 80cm F % N
Men (661)	48(317)	44(290)	36(241)	All ethnic group (men=190)	36(68)	47(88)
Pakistani	50(188)	47(174)	38(140)	Pakistani (111)	38(42)	49(54)
Indian	48 (53)	45(49)	39(43)	Indian (35)	34(13)	46(16)
Bengali	45(49)	36(40)	35(39)	Bengali (28)	36(10)	50(14)
Other	40(27)	40(27)	28(19)	Other (16)	19(3)	25(4)
Women (742)	47(349)	46(345)	44(328)	All ethnic group (women=211)	50(106)	54(113)
Pakistani	49(189)	48(187)	46(180)	Pakistani (119)	25(28)	52(110)
Indian	46 (62)	45(61)	42(57)	Indian (39)	22(8)	49(58)
Bengali	53(60)	52(59)	47(54)	Bengali (27)	32(9)	62(24)
Other	37(38)	37(38)	36(37)	Other (25)	19(3)	56(14)
Total n (1403)	49(692)	48(667)	42(583)	Total (401)	44(175)	51(206)

*MetS: metabolic syndrome, SAA: South Asian American from two community health clinics, BMI: body mass index, WC: waist circumferences

^ NCEP ATP III definition, # Consensus Harmonized definition, @ WHO recommendation BMI,   ω NCEP ATP III recommendation BMI for Asians, β NCEP ATP III recommendation for European Americans

TABLE 4: Frequency of Specific Abnormal Metabolic Syndrome Indicators in US South Asians by gender in Two Community Health Centers in Maryland

# Of Indicators	Most prevalent abnormal indicator	Male	Females	Total
		N (%)	N (%)	N (%)
1 Indicator*	HDLC	333(44)	420 (56)	733(54)
2 Indicators β	HDLC+ TRIG	31%	28%	29%
3 Indicators €	HDLC +TRIG+BLDGLU	20%	16%	18%
4 Indicators ¥	HDLC +TRIG+BLDGLU+WC	7%	8%	7%

* Single most common single abnormal indicator, HDLC: High density lipoprotein cholesterol (≤40 mg/dL men, ≤50 mg/dl in women)
β Two most common abnormal indicators (TRIG: triglycerides ≥150 mg/dl)
€ Three most common abnormal indicators (BLDGLU=fasting blood glucose (≥100mg/dl))
¥ Four most common abnormal indicators (wc ≥ 90 cm in men, ≥ 80 cm in women)

TABLE 5: Sensitivity, Specificity, and Distance in the Receiving Operating Characteristic (ROC) curve for waist circumference cut off values in US South Asian adults by gender

WC cut off (cm)	Sensitivity	Specificity	Area under the ROC curve	Distance in ROC curve
2 or more metabolic risk factors				
Men				
85	80.1	28.3	.5692	.58
86	81.1	28.4	.5680	.56
87	82.2	28.7	.5666	.56
88	**82.4**	**28.7**	**.5652**	**.54**
89	**82.4**	**29.2**	**.5602**	**.53**
90	81.8	29.0	.5659	.55
91	81.5	28.9	.5690	.57
92	81.1	28.8	.5692	.58
93	80.9	28.9	.5695	.58
94	80.9	28.5	.5695	.60
95	80.3	28.4	.5699	.60
Women				
75	85.3	28.4	.5688	.59
76	85.3	28.3	.5680	.57
77	85.3	28.3	.5680	.55
78	85.3	28.0	.5664	.55
79	**86.2**	**26.8**	**.5702**	**.53**
80	**86.2**	**27.5**	**.5686**	**.54**
81	86.2	27.0	.5663	.54
82	86.2	26.7	.5647	.57
83	87.2	26.4	.5677	.58
84	88.1	26.4	.5723	.59
85	89.0	26.1	.5753	.61
86	89.0	25.8	.5737	.62
87	89.0	25.1	.5705	.62
88	89.0	24.6	.5682	.63

*Metabolic risk factors were defined according to the IDF harmonized definition: elevated triglycerides ≥150mg/dl or treatment for hypertriglyceridemia; reduced HDL cholesterol <40 mg/dl for men and <50 mg/dl for women or treatment for this lipid abnormality; elevated blood pressure ≥130 mmHg systolic and/or ≥85mmHg or treatment for previously diagnosed hypertension, elevated fasting plasma glucose ≥100 mg/dl or previously diagnosed T2D.

II. The Relationship between Acculturation and Metabolic Syndrome Risk Among low income South Asian Americans in Two Community Health Centers in Maryland.

Abstract

Background: In the U.S. the wealthy more educated Americans have a better health status compared to those who are less educated and economically disadvantaged. Additionally, obesity and chronic diseases are more prevalent in underserved indigenous populations in the U.S. The opposite is true in developing countries where the poor people have less chronic diseases and obesity, instead, the wealthy are overweight and obese. In these countries, wealth is associated with access to more food, better healthcare and cleaner water. It is unclear how the transition of chronic disease affect first generation immigrants who have different situations in their host countries compared to the U.S. and how this acculturation and assimilation process affect health status.

Objective: In this paper, we were interested in the relationship of acculturation and presence of Mets of subjects that migrated from South Asian countries to the U.S. (first and second generation immigrants) who obtain most of their healthcare services from low-income community health clinics. Our goal was to calculate the gender specific acculturation status (Asian Low Acculturated, Western Acculturated) of SA adults by ethnic groups (Pakistan, India, Bangladesh, Other SA). Examine the gender specific percent of MetS among the acculturation groups and among the ethnic groups by acculturation status. Examine the socio-cultural predictors of MetS among men and women.

Methods: The study consisted of 401 male and females South Asians from the South Asian American Health Initiative (SAAHI) study. MetS was defined using the new consensus

Harmonized criteria, when 3 of the 5 indicators were present. Acculturation status was defined with The Suinn-Lew Asian Self Identity Acculturation tool. The low acculturation group was defined as "Asian Low Acculturated" (LA), and the highly acculturated group was "Western Acculturated" (WA).

Results: The overall percent of MetS was higher in the Asian LA group (44%) compared to the WA group (29%). The study population consisted of a relatively homogenous group of low acculturated individuals (74%) who utilized free and reduced health care services at 2 clinics in Maryland. Males had a greater percent of more western acculturated patterns (37%) compared to females (16%). Both categories of females (Low Acculturated Asians and Western Acculturated) had a greater percent of MetS compared to males (**Table 5**). The number years resident in the U.S. were indicative of higher levels of acculturation for males but not females. Higher levels of education and salary did not seem protective from disease in this population.

Conclusion: It may be that the patterns of disease presented by Low Acculturated SA's are similar to low income Asians from the countries where they migrated. SA males acculturated to Western patterns more than SA females during the same number of years residence in the U.S. Low Acculturated Asians had a greater percentage of subjects (44%) compared to the Western Acculturated Asians (29%) regardless of education and income.

Introduction

Acculturation is a concept related to health behavior and health status of minority populations in a larger multicultural society (106). It is described as a process of change of cultural features (socialization, TV watching, dietary patterns, language) that occurs as a result of continuous contact between two or more groups (144, 145). It is generally a two-way process; but one aspect of acculturation is assimilation. For this study, acculturation consists of the South Asian American immigrant adaption towards of the Western cultural features. Though the concept of acculturation has an older history, its measurement and use in health and disease risk research is a comparatively newer (106). Acculturation may have the potential to identify risk factors that underlie increased prevalence of chronic diseases, particularly in immigrant populations. A proper understanding of this may be helpful in designing intervention programs to reduce the burden of such diseases, to reduce the number of hospitalizations and to increase the quality of life in the SA population.

Apart from the ethnic grouping of people for describing the genetic variation and disease prevalence, before the recognition of health habits and health behaviors as risk factors of chronic diseases, the use of cultural anthropological concepts in health research had been at best peripheral (146). Cultural tradition, beliefs, attitudes, and languages of study participants began receiving attention in health care and disease risk studies when population-based intervention strategies started being implemented. Tanner (147) published classic monographs documenting the use of physical measurements from birth to maturity and how they can be used to study the role of heredity and environment on health problems resulting from abnormal growth and development. Similarly, Yuhasz (106) estimated body fatness which is a known risk factor for

80

several chronic diseases. These body fatness measures such as, skin fold measurements at several body sites are used to define different physical measures of obesity (148). Several of these measures are used for estimates of centralized obesity (BMI and WC) in the context of obesity component of metabolic syndrome (MetS). Worldwide, MetS has been shown to be a risk factor for CVD and diabetes and is an active area of research (149).

Defining Acculturation

Acculturation involves a multifaceted and complex process with individuals of one culture living in another culture with continued exposure (106). As a consequence, SA's living in America have adapted characteristics of another group's culture, consciously or unconsciously. Some of these adapted characteristics are essential for survival such as language, particularly for migrant minority groups. Other important characteristics (eating, exercise, and drug use) have an effect on health and are usually a consequence of adjustments. Acculturation generally consists of three phases described by Chakraborty. These are contact, conflict, and adjustment (106). At each phase of the acculturation process individual and group level changes occur. A path diagram shows how individual, family, as well as societal levels of adaption may influence acculturative changes.
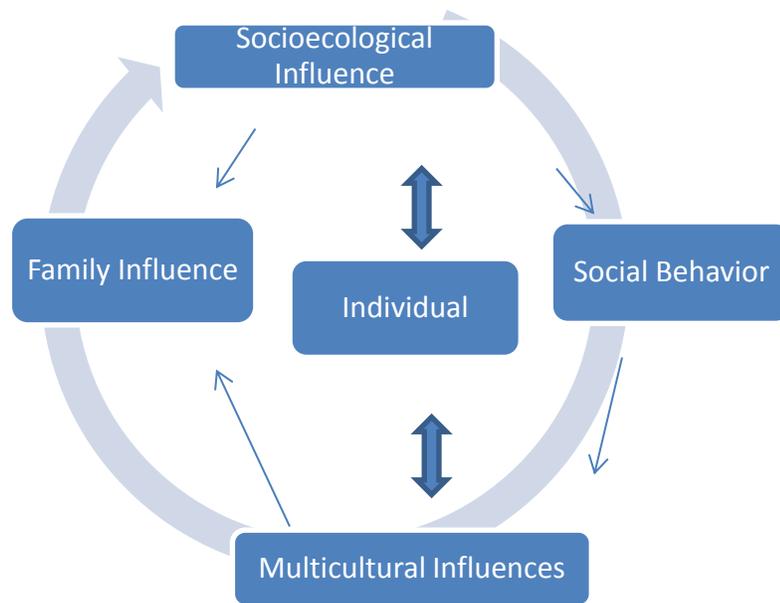
Adapted from Chakaborty (3)

Conceptualization of acculturative features is important because it leads to two competing

theories that describe the process of acculturation: one-dimensional and multidimensional. The

one-dimensional approach assumes that individuals acculturate gradually (but to a higher degree)

to the dominant culture while their connection with the minority culture simultaneously gets

weakened. This assumes that as the minority culture changes, the dominant one remains

unaltered or little changed. This leads to a continuum of the degree of acculturation in

individuals of the minority group that can be measured by a scale such as the SUINN-LEW scale

of acculturation for Asians (150). The multidimensional conceptualization of the process of

acculturation simultaneously allows for acculturation to the dominant culture and maintenance of

non-dominant culture (also included in the SUINN-LEW scale of acculturation) (151).

Acculturation variables comprise of psychological, socio-demographic, contact with native

culture (degree of loss, maintenance and adopting new traits of dominant culture), and language.

The popular dimensions of acculturation measurements in the literature (used mostly in the

context of acculturation studies in US) are: (i) Language (used and/or comfort with) while

speaking, reading, and thinking; (ii) Length of residence in US; (iii) Generation status, parents' birth place; (iv) Ethnicity of past and present friends; (v) Ethnic composition of past, current neighborhood; and (vi) Behavioral preference (for music, radio, TV, movies, books/newspaper, celebrating occasions, diet/food), used one at a time (one-dimensional scale of acculturation), or simultaneously (multi--component measure) (151).

Consideration of acculturation in the context of health studies has been initiated after noting that acculturation influences life style and health behavior in migrant communities and has been shown to be associated with risk factors in chronic health diseases (152). Acculturation especially helps us in a multicultural society such as the US to understand health disparities in the context of the use of health care systems. In the US, research on health behaviors and acculturation patterns have mostly been done in the Hispanic community (tobacco and alcohol consumption, exercise, and sleeping habits) and more recently in the East Asian community (152). Studies have also shown that unhealthy behaviors are a major risk factor contributing to an increased risk of CVD in Mexican Americans (153). We do not know how acculturation affects SA in the US who develop CVD, obesity or MetS.

The objective this paper is to ascertain the gender specific prevalence of MetS in the context of acculturation as it relates to health and disease risk, to examine the relationship between acculturation, gender, and country of origin, to identify risk factors that may underlie increased prevalence in the South Asian American (SAA) immigrant population. Especially considering that SAA have shown an increased prevalence of MetS at lower obesity cut offs using BMI and WC compared to other groups. Examine the gender specific prevalence of MetS among the ethnic groups and acculturation status. Examine the socio-cultural predictors of MetS among men and women.

Methods

Subjects: SAAHI began in May 2012 as a health study for SA in Maryland. We examined 401 men and women between ages 20-70 years from Pakistan, India, Bangladesh, Sri Lanka, Iran, Afghanistan, and Nepal. A cross section of South Asian adult ($\geq$ 20 yrs.) males and females were interviewed on volunteer basis in two religious community centers in Montgomery and Baltimore County, Maryland. The sample included four ethnic categories, Pakistan, India, Bangladesh, and Other SA. The Other SA group was an aggregation of SA's from Iran, Sri Lanka, Nepal and Afghanistan.

We interviewed a convenience sample of volunteer walk-ins (N=401) from the same two clinics to obtain WC, not available from the clinic files. All patients gave informed consent before participation in the study and study protocol was approved by the Institutional Review Board of University of Maryland and also by the review boards of the two community centers. On the subjects that we interviewed (n = 401), we obtained WC and used the new ethnic specific cut off values ($\geq$90cm in males, $\geq$80cm in females) (9). WC was measured at the high point of the iliac crest at minimal respiration to the nearest 0.1 cm at the end of normal expiration. The participant's weight and height were measured on a detecto's promed 6129, (Thornton, CO) scale with subjects wearing light street clothing with shoes removed.

Assessment of Acculturation: Acculturation was measured using the SL-ASIA scale. The SL-ASIA scale is a 21-item multiple-choice questionnaire used to measure Asian American acculturation into Western culture. The scale was designed specifically for Asian populations yielding scores that delineate acculturation status on a unidimensional scale from 1-5 (151). It covers language (4 items), identity (4 items), friendship (4 items), behaviors (5 items), generation/geographic history/enclave residence (3 items), and attitudes (1 item). A final

acculturation score was calculated by dividing the total value by 21; a score ranging from 1.0-2.0 connotes low acculturation, reflecting high Asian identification, a score between 2.1-3.9 connotes biculturation and a score of 4.0-5.0, reflecting high Western acculturation or assimilation (109). The total score has been shown to reflect the overall level of acculturation. Studies have shown that the final score is both reliable and valid, alpha coefficients range from 0.72-0.91(151, 154). Reliability studies show that the Cronbach's alpha for the SL-ASIA scale for Asian Americans was between 0.91 and 0.88, reflecting high reliability (109). A validity study showed that the SL-ASIA scores were significantly correlated with demographic information hypothesized to reflect levels of Asian American identity (109). For example, high SL-ASIA scores were associated with having attended school in the United States over a longer period of time, during which time the SL-ASIA's Asian identity score would have been reduced. There are also 5 multidimensional items scored on a likert scale. This alternative scoring model for SL-ASIA classifies subjects into three categories: traditional, bicultural, and assimilated by measuring acculturation as a multidimensional rather than a unidimensional construct (155).

Assessment of MetS: We used the new consensus harmonized definition of MetS (30). These indicators are: 1) "Elevated triglycerides level: $\geq$ 150 mg/dl, 2) Reduced HDL cholesterol level: < 40 mg/dl in men and < 50 mg/dl in females or specific treatment for these lipid abnormalities, 3) Elevated blood pressure: systolic BP $\geq$ 130 or diastolic BP $\geq$ 85 mmHg or treatment of previously diagnosed hypertension, 4) Elevated fasting plasma glucose: FPG $\geq$ 100 mg/dl or previously diagnosed type 2 diabetes" 5) Central obesity measured by ethnic specific WC cutoffs of males (>90cm) and females (>80cm) (10), (28, 29). BMI was calculated by dividing weight by squared height (Kg/m^2) and categorized as; underweight (BMI<18.5 Kg/m^2), normal (18.5 $Kg/m^2 \leq$ BMI < 20.9 Kg/m^2), overweight (21 $Kg/m^2 \leq$ BMI < 22.9 Kg/m^2) (156), obese (BMI $\geq$

23.0 Kg/m^2) as recommend for SA by WHO (9). Subjects were told to remove hair ornaments and buns from the top of the head in order to measure stature accurately MetS indicator data were taken from patient files.

Statistical Analysis: A power calculation was performed based on the overall prevalence of MetS in the SA population (27%) (1), which resulted in 400 subjects with a reasonable minimum effect of $\alpha=0.05$, a minimum power to detect that effect, and the sample size that would achieve that desired level of power was 80%. All data were analyzed using SAS 9.2 statistical software (SAS Institute, Cary NC). Data were expressed as mean $\pm$ SD; student t-test was used to compare means between groups, and chi-square test to compare proportions between groups. We used ANOVA from GLM with Sheffe adjustment for multiple unequal comparisons. $P<0.05$ was considered statistically significant to compare the characteristics of MetS indicators between the four groups. A logistic regression was used to evaluate the associations between presences of MetS and acculturation, exercise, years in the U.S, years in school, income, and country of origin. Age and sex were covariates.

Results

We had a total of 401 subjects who were interviewed and categorized into Asian Low

Acculturated (LA) (74%) and Western Acculturated (WA) (26%) acculturation groups with 190

males and 211 females. **Table 6** shows background descriptive statistics for the SA's in this

study.   The mean age of the subjects was 47±3.5 years old. The average length of time resident

in the U.S and time of school completed was 11 and 12 years, respectively. Males were

significantly taller and heavier compared to females but the average WC and age were generally

similar at 97±12 cm for males and 96±13 cm for females at an average age of 48±2.5 years. The

average number of years in school and years of education were also significantly higher for

males, with males having more education and more years in the U.S. compared to females

(**Table 6**). All of the MetS indicator values, except blood pressure, were also significantly

different; males having higher fasting blood glucose values and triglycerides, and lower HDLC

values (**Table 6**).

Acculturation in the Population: 80% of the subsample were classified as Asian LA (low

acculturated) (N=293) based on their scores (1.0-2.0) from the SL=ASIA questionnaire. The

average number of years resident in the U.S for Asians was (9.43±2.3) and WA (western-high

acculturated) was (27.0±4.0), and they were statistically different (p<0.001) from each other

(**Table 8**). The mean numbers of years were statistically significant for differences between LA,

Bicultural and WA groups at p<0.001. We used a Sheffe adjustment for the means for

unbalanced design. For further analysis we combined the Bicultural (score 2.1-3.9) and WA

(score 4.0-5.0) groups into one group and called them WA for a new category with 102 subjects

for analyses where sample size was low (**Table 7**).

According to the SL-ASIA question about generations, 387 (97%) participants identified themselves as first generation. Remaining 13 (3%) were second generation. The LA group had 76% of subjects who were first generation immigrants and 15% as second generation immigrants. The WA group contained 24% who were first generation immigrants and 85% second generation.

Gender and Acculturation: More females 84.1% (N=174) were identified as LA than males 63.3% (N=119). WA were the smallest group and equally representative between sexes, males 2.7% (N=5) and females 3.4% (N=7). There were gender differences between the acculturation groups that were statistically different (p <0.001) as measured by chi-square analysis. There were a greater number of LA females than LA males (p<0.001). There were also more LA males and females than WA males and females (P<0.001) (**Table 8**). Out of all of the continuous MetS indicators the only statistically significant associations were systolic blood pressure (P<0.05), and years resident in U.S. (P<0.001) between the two acculturation groups using ANOVA GLM. LA males were 10 years older, lived in the U.S. for 4 years less, exercised significantly less average minutes per day, and had 2 years less education compared to the more WA males (**Table 7**). The LA females were older (48±13 yrs.) than WA females (42±14 yrs.) and resided in the U.S. on average 9 years less. LA females also exercised on average 17 minutes less, and had higher systolic blood pressure compared to the WA females.

We examined the differences between the acculturation groups by BMI categories (normal, overweight, and obese). The majority of LA (males 74% and females 79%) and Bicultural (males 64% and females 70%) groups were obese (≥ 23.0 kg/m^2). The obese BMI category also had the highest percent of MetS regardless of acculturation status (**Table 11**).

Patterns among ethnic groups: There majority of our sample came from the following countries: Pakistani (n=226) and 76% (N=171) were LA, Bicultural 21% (49) and WA 3% (N=6). India (n=74) who were LA 68.9% (N=51), Bicultural 24.32% (n=18) and WA 6.8% (N=5). Bangladesh (n=54) who were LA 75.9% (N=41), Bicultural 24.1% (N=13), and no Bengalis were in the WA group. The Other SA (N=30) subjects were LA 75.0%, and WA 25.0% N=10 with no one in the Bicultural group. The average number of years resident in the US between each ethnic group (country of origin (CO)) and acculturation groups were significantly different (**Table 9**). We also tested other dependent variables that were associated with acculturation levels. Since our values for WA and Bicultural together account for about 21% prevalence, we had to combine the groups for Bengali and Other SA. We evaluated several dependent variables between the acculturation levels (Western, Bicultural, and Western) to assess differences due to acculturation. The dependent variables we used included: years in U.S., years in school, minutes of exercise, and the MetS indicators (HDL-C, triglyceride levels, fasting blood glucose, systolic and diastolic blood pressure, waist circumference, body mass index).

Pakistan: Years in school was statistically significant for Pakistan ($p<0.05$) WA vs. LA patterns ($p<0.05$), mean years in school for LA Pakistani =11.12 ± 1.4 yr., Bicultural Pakistani=12.47 ± 1.6 yr., and WA Pakistani=15.17 ± 1.2 yr. Minutes of exercise model was statistically significant at ($p< 0.0001$) (**Table 9**). LA and Bicultural Pakistani men had significantly different WC values ($p<0.05$). The mean WC of LA was 99.8 cm and Bicultural was 94.2 cm. None of the other comparisons above were significant.

India: Bicultural Indians resided in the USA significantly longer than the LA group ($p<0.05$) and the WA vs. LA group were residing in the US statistically longer as well ($p <0.05$). Westernized Indians exercise more than LA Indians, (LA = 22 ± 2.4 min, WA = 57 ± 3.6 min,

Bicultural 31±3.2 min.) not statistically significant. Fasting blood glucose was significantly different for Indian females at (P<0.05). The number of years in school was not significant between Asian and Western Indians. WC, BMI, weight, HDL-C, triglycerides, fasting blood glucose, systolic blood pressure and diastolic blood pressure were not significantly different for Indians.

Bangladesh and Other SA: none of the other comparisons were significant for the remaining groups.

Metabolic Syndrome Prevalence and Acculturation: The association between MetS and acculturation was significant (p<0.05) (**Table 10**). Asian LA group had significantly greater prevalence of MetS 44% compared to WA group, 29%. We also wanted to see which groups of abnormal MetS indicator values (HDLC, WC, BMI, triglycerides, fasting blood glucose, systolic BP, diastolic BP) were statistically different for LA and WA. None of these comparisons were significantly different between males and females. The only difference noted was that the WA group exercise significantly (P<0.05) longer on average compared to LA group (Asian= 15.8 min, Bicultural=29.3 min, Western=60.8 min).

Predicting MetS using Acculturation: A Logistic regression model with MetS as dependent variable and years in the U.S, BMI (normal, overweight, obese), generation, education, exercise (yes or no), sex (male or female), country of origin, acculturation (LA vs. WA), and eating fast foods (yes or no) as independent variables was performed. The final model was statistically significant (P<0.001) and including sex, BMI group, fast foods, and exercise as independent variables. The odds for females to develop MetS was higher than males and this variable is significant at p<0.001. As obesity and eating fast foods increased, MetS increased (P<0.05) and as days of exercise increased MetS decreased (P<0.05).

Discussion

This study provides a background of the relationship between acculturation and MetS and other factors influencing the development of MetS. This is the first study to enroll large numbers of SA from different countries (Pakistan, Bangladesh, Sri Lanka, and Nepal). A total of 75% of this low income SA population were LA Asians and 44% had MetS. Higher education level and higher income were expected to reduce the burden of disease but these variables were not protective of this SA population. The Asian LA group had greater prevalence of disease compared to the WA. This may indicate that LA Asians tend to develop disease patterns similar to their compatriots in India, Pakistan, Bangladesh, etc. In fact, the adoption of an unhealthy western diet and lack of physical activity may increase the burden of disease further. In this study, obesity rates were very high in both males and females across the acculturation groups. Obese subjects had a greater chance of developing MetS compared to normal weight subjects but the WA group had a greater percentage of normal weight subjects, 21.5% compared to normal weight subject 11% in LA group.

Males were significantly taller and heavier compared to females but the average WC values were generally similar (cut off value is 90cm for males) for males (cut off value is 80cm) for females at an average age of 48 years for both genders. It is important to note that women (≥80cm) were much further from that indicator value compared to males (≥90cm).

For females 59% were LA and 32% were WA and the pattern of MetS in females was similar regardless of the acculturation level (**Table 5**). Females had a greater chance of developing MetS. A larger proportion of males 67% were more acculturated compared to females (16%) as we expected. Expectations in gender roles in the SA population necessitate men to leave the home and become gainfully employed. Joy (157) found results similar to this

study they also found that men were more acculturated than women. These results were different than work completed by Dodani (111) where 67% of subjects were highly acculturated.

Obese males who were Asian LA had the greatest prevalence of MetS. Obese Asian males had a prevalence of 52% for MetS compared to 43% bicultural males who had MetS. Therefore, the cultural preferences attributed to less acculturation increases the likelihood of disease among SA males but not for females at the same level of body fatness. For men, it seems that holding on to cultural values may increase risk towards the development of MetS and in turn T2D and CVD.

MetS was significantly higher in the Asian LA group than WA group and females incurred a greater risk factor. The logistic regression showed that sex, BMI, eating fast food, and minutes of exercise were significant predictors of MetS. This may mean that the preference for food and the role of diet is an important factor in MetS in the SA population. It may also be attributed to a genetic role in this population (158).

Bicultural females displayed a higher prevalence of MetS 33% compared to the Asian females 25%. This may be due to dietary differences in subjects eating more meals away from home and have adopted high fat diets and deal with the stress of working. Much of the population has minimum wage jobs and cannot afford healthcare. Eating fast foods was a significant predictor of developing MetS in the logistic model. The number of males (15% and 14%) and females in the overweight category had about the same prevalence of MetS (9% in both).

Normal weight males and females in the Asian LA group had a higher prevalence of MetS compared to normal weight WA males and females. This is similar to the results with the obese individuals who have greater prevalence of Mets in the Asian LA status. Other studies

have shown that individuals who are less acculturated experience more overall cultural value conflict than individuals who are more acculturated. These conflicts of values may further the burden of disease according to some researchers (158, 159). Joy (157) used the Suinn-Lew scale among Indian and Pakistani attitudes towards seeking professional help related to mental health and found that acculturation level was predictive of health seeking behavior. More acculturated Asians were more likely to seek mental help.

In the Dodani (111) study on SA also using the same Suinn-Lew scale, the logistic regression model, $\geq$10 years stay in the US (P<0.05), cholesterol level $\geq$200 mg/dl (P<0.001), BMI $\geq$23 kg/m^2 (P<0.01) and family history of coronary artery disease (CAD) (P<0.05)) were found to be independent predictors of CAD. The same study showed similar results with T2D as an outcome. Those with high CAD had greater (CI 1.32 to 6.68) odds of having total cholesterol $\geq$200 mg/dl compared to those without CAD.

Conclusion

Acculturation status presents an alternative view of disease patterns and behavior for low income SA's who migrated to the U.S. This is the first study to compare SA ethnic groups (Indians, Pakistani, Bengali, and Other SA) in the U.S. Subjects in the Asian LA group had greater MetS compared to those who were WA. Females had a greater prevalence of Asian LA and increased MetS. Males resided in the U.S. longer than females and presented higher levels of western acculturation and education. The prevalence of MetS increased as obesity increased. Further studies are needed on SA's in the U.S.

References

1. Green SM, Watson R. Nutritional screening and assessment tools for use by nurses: literature review. Journal of Advanced Nursing 2005;50(1):69-83. doi: 10.1111/j.1365-2648.2004.03350.x.
2. Kawada T. Predictive ability of metabolic syndrome for incident cardiovascular disease in non-diabetic subjects. International journal of cardiology 2014.
3. Chakraborty BM, Chakraborty R. Concept, measurement and use of acculturation in health and disease risk studies. Collegium Antropologicum 2010;34(4):1179-91.
4. Suinn RM, Khoo G, Ahuna C. The SUINN-LEW Asian Self-Idendity Acculturation Scale - Cross-Culturatl Information. Journal of Multicultural Counseling and Development 1995;23(3):139-48.
5. Suinn RM, Ahuna C, Khoo G. The Suinn-Lew Asian Self-Identity Acculturation Scale: Concurrent and Factorial Validation. Educational and Psychological Measurement 1992;52(4):1041-6.
6. Lee S, Chen L, He X, Miller MJ, Juon H-S. A cluster analytic examination of acculturation and health status among Asian Americans in the Washington DC metropolitan area, United States. Social Science & Medicine 2013;96(0):17-23. doi: http://dx.doi.org/10.1016/j.socscimed.2013.07.007.
7. Wallace PM, Pomery EA, Latimer AE, Martinez JL, Salovey P. A review of acculturation measures and their utility in studies promoting Latino health. Hispanic Journal of Behavioral Sciences 2010;32(1):37-54. doi: 10.1177/0739986309352341.
8. Alberti KGMM, Eckel RH, Grundy SM, et al. Harmonizing the Metabolic Syndrome: A Joint Interim Statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. Circulation 2009;120(16):1640-5.
9. Suinn RM, Rickardfigueroa K, Lew S, Vigil P. The SUINN-LEW Asian Self-Identity Acculturation Scale - An Initial Report. Educational and Psychological Measurement 1987;47(2):401-7. doi: 10.1177/0013164487472012.
10. Reliability and validity of the Suinn-Lew Asian Self-Identity Acculturation Scale with Japanese temporary residents. Japan: Psychologia Society, 1995:17-21.
11. Abe-Kim J, Okazaki S, Goto SG. Unidimensional versus multidimensional approaches to the assessment of acculturation for Asian American populations. Cultural diversity & ethnic minority psychology 2001;7(3):232-46. doi: 10.1037/1099-9809.7.3.232.
12. Alberti KGMM, Eckel RH, Grundy SM, et al. Harmonizing the Metabolic Syndrome. Circulation 2009;120(16):1640-5.
13. Alberti KGMM, Zimmet P, Shaw J. Metabolic syndrome—a new world-wide definition. A Consensus Statement from the International Diabetes Federation. Diabetic Medicine 2006;23(5):469-80.

14. Tan C-E, Ma S, Wai D, Chew S-K, Tai ES. Can we apply the National Cholesterol Education Program Adult Treatment Panel definition of the metabolic syndrome to Asians? Diabetes Care 2004;27(5):1182-6.

15. Lear SA, Toma M, Birmingham CL, Frohlich JJ. Modification of the relationship between simple anthropometric indices and risk factors by ethnic background. Metabolism: Clinical And Experimental 2003;52(10):1295-301.

16. Misra A, Khurana L, Isharwal S, Bhardwaj S. South Asian diets and insulin resistance. British Journal of Nutrition 2009;101(4):465-73. doi: 10.1017/s0007114508073649.

17. Sheikh AJ. Gender and levels of acculturation as predictors of attitudes toward seeking professional psychological help and attitudes toward women among Indians and Pakistanis in America. US: ProQuest Information & Learning, 2001.

18. Dodani S, Dong L. Imacpt of Acculturation on Coronary Artery Disease in the South Asian Immigrants-Unique Population with Increased Risk. Journal of Epidemiology and Community Health 2011;65:A237-A. doi: 10.1136/jech.2011.142976h.100.

19. Narne P, Ponnaluri KC, Singh S, Siraj M, Ishaq M. Relationship between NADPH oxidase p22phox C242T, PARP-1 Val762Ala polymorphisms, angiographically verified coronary artery disease and myocardial infarction in South Indian patients with type 2 diabetes mellitus. Thrombosis Research 2012;130(5):e259-e65. doi: http://dx.doi.org/10.1016/j.thromres.2012.09.012.

20. Nishikawa T, Edelstein D, Du XL, et al. Normalizing mitochondrial superoxide production blocks three pathways of hyperglycaemic damage. Nature 2000;404(6779):787-90.

Tables

TABLE 6: Background Descriptive Variables on South Asian Americans Adults by Gender in Two Community Health Centers in Maryland from Interviews

VARIABLE	N Total	AVERAGE ± SEM	MIN-MAX	Males N=190	Females N=211	P value
AGE (yrs)	401	46.9±12.9	18-67	47.5±12.4	46.5±13.2	0.4097
HEIGHT (in)	401	64.0±3.8	51.5-70.0	66.5±3.4	61.6±2.8	0.0001
WEIGHT (lbs)	401	163.6±33.8	81.2-350.0	173.1±33.8	155.7±31.1	0.0001
BMI (kg/m^2)	401	28.0±5.2	16.5-53.4	27.4±5.0	28.6±5.4	0.0123
WC (cm)	401	96.4±12.8	59-151	96.6±11.9	96.1±13.4	0.6465
YEARS IN SCHOOL	401	11.9±4.2	0-24.0	13.1±3.5	10.8±4.5	0.0001
YEARS IN U.S	401	10.9±8.8	1-42.0	12.0±8.8	10.0±8.7	0.0201
DAYS OF EXERCISE	401	2.2±29.8	0-7	2.1±2.4	2.3±2.6	0.3944
MINUTES OF EXERCISE	401	22.0±13.2	0-240.0	23.7±31.5	20.5±28.2	0.2861
GLUCOSE λ	400	111.8±5.4	20-424	118.5±60.8	105.7±37.7	0.0130
TRIGLYCERIDES λ	399	155.2±104.6	29-990	171.1±124.8	140.8±79.6	0.0044
HDLC λ	399	46.6±14.3	22-152	43.5±13.2	49.5±14.6	0.001
SYS BP^	399	121.7±17.3	80-180	122.9±120.7	120.7±118.2	0.2072
DIA BP^	399	76.5±10.7	40-120	77.5±10.6	75.7±10.7	0.0844

λ = mg/dL, ^ = mmHg, HDLC= high density lipoprotein cholesterol

TABLE 7: Descriptive Variables between Asian Low Acculturated and Western Acculturated Adults by Gender in Two Community Health Centers in Maryland

	Low		Bi & Hi		P Value	
	Mean ± SEM or (%) N		Mean ± SEM or (%) N			
	Males	Females	Males	Females	Males	Females
Age (yrs)	51.0±10.4	47.6±12.9	41.4±13.4	42.3±13.6	<0.001	0.0323
Height (in)	66.4±3.8	61.6±2.9	66.6±2.7	62.1±2.3	0.5941	0.2966
Weight (lbs)	174.2±35.9	155.4±29.7	170.1±27.7	159.4±38.0	0.3829	0.5704
BMI (kg/m^2)	27.7±26.8	28.9±5.3	26.9±28.9	28.9±6.1	0.3021	0.9282
WC (cm)	97.9±12.0	96.1±13.5	94.4±10.8	96.3±13.7	0.0492	0.9600
Years in U.S	10.7±8.1	8.4±6.9	14.1±9.6	17.6±12.1	0.0100	0.0002
Min of Exercise	19.6±26.7	17.8±22.7	30.9±37.8	34.1±45.6	0.0306	0.0522
Years in School	12.6±3.44	10.6±4.5	14.0±3.6	11±9.4	0.0084	0.6839
Triglycerides λ	174.9±112.8	143.2±80.6	165.7±145.3	134.6±77.1	0.6481	0.5725
HDLC λ	43.6±13.5	49.1±12.6	43.1±12.8	51.9±23.0	0.8175	0.5093
Glucose λ	119.3±58.6	104.6±99.9	113.2±56.6	113.9±91.9	0.4829	0.4089
SYS BP ^	124±15.1	121.9±19.1	121.3±15.5	115.0±17.0	0.2429	0.0525
DIS BP ^	77.4±10	76.0±10.6	77.8±11.7	73.2±10.4	0.8088	0.1560
High School*	33(62)	43(90)	11(21)	8(16)		
Bachelor/Grad $	28(52)	29(60)	24(45)	6(13)		
1st Generation	63(118)	83(172)	33(62)	14(29)		
2nd Generation	.5(1)	0(1)	4(7)	2(4)		
Income $0-$30K	41(77)	64(132)	21(40)	14(29)		
Income $31-$60K	22(41)	18(38)	15(28)	2(4)		

*completed high school, λ = mg/dL, ^ = mmHg, $ completed bachelor degree or graduate degree

TABLE 8: Acculturation Frequency based on SUINN-LEW for South Asian American Adults by gender in Two Community Health Centers in Maryland

	Score	(%) N	Years in US Mean ±SEM	Males %, N N=188	Females %, N N=207
*≠ Low Acculturated	1.0-2.0	(74) 293	9.43±2.3	*(63)119	*(84)174
*€ Biculturated	2.1-3.0	(23) 90	15.8±3.4	(34) 64	(11) 26
≠€ High Acculturated/ Western Acculturated	3.1-5.0	(3) 12	27.2±4.0	(3) 5	(3) 7
Bi & Hi Acculturated/ Western Acculturated	2.1-5.0	(26) 102	14.0±3.2	*(37) 69	*(16) 33

€ Statistically significant at p<0.05
≠ statistically significant at p<0.001
*statistically significant at p<0.001

TABLE 9: Acculturation Frequency Based on SUINN-LEW Scale for South Asian American Adults for Ethnic Groups in Two Community Health Centers in Maryland

	ASIAN	WESTERN	Male	Female
Pakistani (226)	*171 (75.7%)	*55 (24.3%)	λ373 (49%)	λ388 (51%)
Years in U.S	NS		P=0.0191	
Years in School	NS		P=0.0152	
BMI	P=0.0577		p=0.0067	
HDLC	NS		P<0.001	
FBG	NS		P=0.025	
WC	NS		P=0.0572	
Indian (74)	**51 (68.9%)	**23 (31.1%)	110 (44.9%)	135 (51.0%)
YUS	NS		P=0.0172	
Bengali (54)	*41 (75.9%)	*13 (24.1%)	110 (49.1%)	114(50.1%)
YUS	NS		p<0.0001	
Other (40)	@30 (75.0%)	@10 (25.0%)	&68 (39.7)	&103 (60.2)

*(P<0.001), λ= (P<0.05) by acculturation status

**(P <0.001), & (P<0.05), @ (P<0.001)

BMI= body mass index, HDLC = high density lipoprotein cholesterol, FBG = glucose levels, WC= waist circumference, YUS = years in the US, NS = not significant

TABLE 10: Acculturation Frequency Based on SUINN-LEW Scale for South Asian American Adults with Metabolic Syndrome by Gender in Two Community Health Centers in Maryland

	Total		METS* Males		METS Females	
	Yes **% (N)**	No % (N)	**Yes** **% (N)**	No % (N)	**Yes** **% (N)**	No % (N)
ASIAN (LA)	**44(128)**	56(164)	**29(34)**	71(85)	**54(94)**	21(79)
WESTERN (WA)	**29(30)**	18(72)	**20(14)**	80(55)	**48(16)**	51(17)
p-value	**0.0105**		**0.2094**		**0.5370**	

*METS = Metabolic syndrome according to the new consensus Harmonized definition require 3 of the following 5; 1) "Elevated triglycerides level: ≥ 150 mg/dl, 2) Reduced HDL cholesterol level: < 40 mg/dl in men and < 50 mg/dl in females or specific treatment for these lipid abnormalities, 3) Elevated blood pressure: systolic BP ≥ 130 or diastolic BP ≥ 85 mmHg or treatment of previously diagnosed hypertension, 4) Elevated fasting plasma glucose: FPG ≥ 100 mg/dl or previously diagnosed type 2 diabetes, 5) WC: males (≥90cm) females (≥80cm). LA= low acculturated, WA = western acculturated

Table 11: Percent of Metabolic Syndrome# among South Asian American Adults by Acculturation Status based on SUINN-LEW Scale and BMI*groups in Two Community Health Centers in Maryland

		Normal N %	Overweight N %	Obese N %
Asian/ Low Acculturated	Males	13 (11%) 3 (23%)	18 (15%) 3 (17%)	86 (74%) 45 (52%)
Asian/ Low Acculturated	Females	19(11%) 3 (16%)	16 (9%) 4 (25%)	135 (79%) 82 (61%)
Western Acculturated	Males	15 (22%) 2 (13%)	10 (14%) 3 (30%)	44 (64%) 19 (43%)
Western Acculturated	Females	7 (21%) 1 (14%)	3 (9%) 1 (33%)	23 (70%) 14 (61%)

*BMI groups according to WHO recommendations for SA: Normal (18.5-20.9 kg/m^2), Overweight (21.0-22.9 kg/m^2), Obese ($\geq$23.0 kg/m^2)

#*Metabolic syndrome according to the new consensus Harmonized definition require 3 of the following 5; 1) "Elevated triglycerides level: $\geq$ 150 mg/dl, 2) Reduced HDL cholesterol level: < 40 mg/dl in men and < 50 mg/dl in females or specific treatment for these lipid abnormalities, 3) Elevated blood pressure: systolic BP $\geq$ 130 or diastolic BP $\geq$ 85 mmHg or treatment of previously diagnosed hypertension, 4) Elevated fasting plasma glucose: FPG $\geq$ 100 mg/dl or previously diagnosed type 2 diabetes, 5) WC: males ($\geq$90cm) females ($\geq$80cm).

III. Associations of Diet Quality, Acculturation, and Metabolic Risks Among low income South Asian Americans in 2 Community Health Centers in Maryland

ABSTRACT

Background: There is a continuing need to examine the relationship between diet quality and health in the low-income South Asian (SA) subpopulation. Dietary and acculturation-related changes may augment the effects of poverty related to Metabolic Syndrome (MetS).

Objective: We calculated the Healthy Eating Index- 2010 (HEI2010) scores to assess the diet quality among a subpopulation of low-income SA adults in Maryland that utilize community health clinics. We also wanted to examine the association between gender and age specific acculturation status, diet and MetS and its indicators.

Design: We studied 401 adult SA men and women in a cross sectional analysis using the Automated Self-Administered 24-hour recall (ASA24) to calculate diet quality using the dietary guidelines and recommendations for 2010. Scores ranged from 0 to 100 based on 12 dietary criteria and a low HEI score (≤ 80) indicates a poor diet. Volunteers from two low-income community health clinics in Maryland were studied by interview administered questionnaires and laboratory data from patient files. SUINN-LEW questionnaire was used to classify the sample into two groups: Western Acculturated (WA) and Asian Low Acculturated (LA). MetS was defined by the new consensus harmonized definition by the presence of ≥ 3 of the five abnormal indicators.

Results: SA adults had a composite HEI2010 score of 73 ± 1.2. A score, suggesting diets need improvement. Older SA males had the highest intake of total calories, 2286 kcals $\pm$ 596 compared to younger males 2037 kcals $\pm$ 595. Older SA females had the highest prevalence of MetS (73%) compared to younger females (37%) and older males had a higher prevalence of

MetS (55%) compared to younger males (28%). Western acculturated males and females consumed increased macronutrients compared to the Asian low acculturated subjects. Western acculturation status was not related to increased MetS.

Conclusions: Acculturation can present positive influences on immigrants when they have attained greater education and income but also have detrimental effects on immigrants by adopting a fast-food lifestyle leading to greater health disparities. The SA population in our study was largely Asian low acculturated. Older SA ($\geq$65 yrs.) had spent more time (years) in the U.S and had increased percentage of MetS compared to younger SA's. Further research is needed in this area in the SA population

INTRODUCTION

Acculturation coupled with migrant effects (93, 160) encountered by low-income SA immigrants in the U.S. may influence the increased prevalence of MetS and its indicators. The escalation of obesity and MetS risk increased, as migrants became more affluent and urbanized. This increased risk indicated an important role of environmental factors such as diet (161). SA migrants, who are particularly predisposed to develop insulin resistance and type II diabetes (T2D), showed a nearly four times increase in prevalence rates of T2D than rural sedentary populations (93). The determinants were found to include nutrition transition, physical inactivity, gene-environment interactions, stress, and other factors such as ethnic susceptibility. However, contradicting trends were also seen in some migrant communities and have been explained by various phenomena such as healthy migrant effect in the Hispanic population, and adherence to traditional diets. In the U.S, little is known about migrant low income SA dietary habits and acculturation patterns and how they affect disease, primarily MetS leading to type II diabetes and cardiovascular disease (CVD).

In the U.S., CVD is the leading cause of death (128) and yet little is known about MetS in SA's, presently the second fastest growing minority. MetS is a clustering of atherogenic metabolic abnormalities that leads to CVD and T2D. In 2009, new harmonized definition guidelines required the presence of three or more of the following five components: i) abdominal obesity (waist circumference: men >90 cm, women >80 cm), ii) elevated triglycerides ($\geq$ 150 mg/dl) or use of medication, iii) low HDL-C (<40 mg/dl in men, <50 mg/dl in women) or use of medication , iv) elevated blood pressure (systolic or diastolic $\geq$ 130/85 mmHg or use of antihypertensive medication), and v) elevated fasting glucose (>100mg/dl), or use of antihypertensive medication (9).

The HEI2010 is a measure of diet quality in terms of conformance with the newest federal dietary guidance (162). The HEI2010 retains several features of the 2005 HEI version and captures they key recommendations and is used to assess the diet quality of the U.S. population and low-income subpopulations in dietary patterns research (118). HEI2010 is made up of 12 components, 9 adequacy components (total fruit, whole fruit, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, fatty acids) and 3 moderation components (refined grains, sodium, empty calories). The maximum point values of the components and scoring standards are found in **Appendix 1**.

According to the Center for Nutrition Policy and Promotion (CNPP) a score of 50 or below indicates a poor diet and below 80 needs improvement.

Poor diet and physical inactivity are the most important factors contributing to an epidemic of overweight and obesity in the USA. The most recent data indicate that 72% of men and 64% of women are overweight or obese (163). The prevalence of overweight and obesity in the U.S is of major concern because individuals who are overweight or obese have in increased risk of many health problems. Poor diet and physical inactivity are associated with major causes of cardiovascular disease (CVD), hypertension (HTN), type 2 diabetes (T2D), and others. 81.1 million Americans, (37%) of the population, have CVD (164). Major risk factors include high levels of blood cholesterol and other lipids, T2D, HTN, metabolic syndrome, overweight and obesity, physical inactivity, and tobacco use. 16% of U.S. adult population has high blood cholesterol (165). Ultimately, obesity can increase the risk of premature death. Some racial and ethnic population groups are disproportionately affected by the high rates of overweight, obesity, and associated chronic diseases. These diet and health associations make a focus on improved nutrition and physical activity choices ever more urgent. These associations also provide

important opportunities to reduce health disparities through dietary and physical activity changes.

The Dietary Guidelines for Americans are jointly issued and updated every 5 years by the Department of Agriculture and the Department of Health and Human Services. They provide authoritative advice to consume fewer calories, make informed food choices, and be physically active to attain and maintain a healthy weight, reduce risk of chronic disease, and promote overall health.

Recommendations from dietary guidelines for Americans are for ages 2 years and over, including those at increased risk of chronic disease. The guidelines encourage Americans to focus on eating a healthful diet, one that focuses on foods and beverages that help achieve and maintain a healthy weight, promote health, and prevent disease.

SUBJECTS AND METHODS

Subjects:

The South Asian American Health Initiative (SAAHI) is a health initiative to investigate metabolic risk factors leading to CVD, T2D, and related outcomes of low income SA's in Maryland. A total of 1400 participants, aged 18-70 years were enrolled in the study between June 2012 and June 2013 and 400 had 24-hour recalls for dietary analysis. SA adults from Pakistan, India, Bangladesh, Sri Lanka, Iran, Afghanistan, and Nepal were included in this survey. We excluded those with type 1 diabetes, cancer, AIDS, and women that are pregnant or breast-feeding. A convenience sample of unrelated volunteer subjects was interviewed from two religious community centers in Maryland. All patients gave informed consent before participation in the study and the research protocol was approved by the institutional review board of University of Maryland and also by the review boards of the two community centers.

Collection and classification of MetS:

The diagnosis of MetS was based on the new harmonized definition guidelines and required the presence of three or more of the following five components: i) abdominal obesity (waist circumference (WC): men ≥90 cm, women ≥80cm), ii) elevated triglycerides (≥ 150 mg/dl or statins), iii) low HDL-C (<40 mg/dl in men, <50 mg/dl in women), iv) elevated blood pressure (systolic or diastolic ≥ 130/85 mmHg or use of antihypertensive medication), and v) elevated fasting glucose (>100mg/dl or hypoglycemic agents).

On the subjects that we interviewed (n = 400), we obtained WC and used the new ethnic specific cut off values mentioned above. WC was measured at the high point of the iliac crest at minimal respiration to the nearest 0.1 cm at the end of normal expiration. The participant's

weight was measured on a detecto's promed 6129, (Thornton, CO) scale with subjects wearing light street clothing with shoes removed.

BMI was calculated by dividing weight by squared height (Kg/m^2) and categorized as; normal (18.5 $Kg/m^2 \leq$ BMI <20.9 Kg/m^2), overweight (21.0 $Kg/m^2 \leq$ BMI <22.9 Kg/m^2), obese (BMI $\geq$ 23.0 Kg/m^2) as recommend for SA's by WHO (24). Subjects were told to remove hair ornaments and buns from the top of the head in order to measure stature properly.

Collection of 24-hour dietary recalls:

The diet quality and intake were assessed from the clinics by using the ASA24. All interviews were collected and entered by a nutritionist who spoke the language of the participants. Intakes of foods and nutrients were estimated with SAS 9.2 (SAS Institute, Cary, NC). ASA24 was used to calculate the HEI2010. Assigning HEI2010 scores to a set of foods required translating them into amounts of food groups that were consistent with the USDA Food Patterns (166).

Scoring and Weighting: The HEI2010 components can be considered as a set of scores, each of which measures compliance with a different aspect of the Dietary Guidelines for Americans (DGA), and the component scores can be summed to derive a total score. The maximum number of points allocated to each component serves as a weighting factor when the component scores are summed. Most components are weighted equally at 10 points. Fruits, vegetables, and protein foods have two components (total and a subgroup) that are allotted 5 points each. Empty calories is allotted 20 points because the added sugars, solid fats, and alcohol that make up this component contribute excess calories and may displace nutrient-dense foods from the diet. HEI2010 used a density approach to set standards, per 1,000 calories or as a percentage of calories and it employs least-restrictive standards, those that are easiest to achieve among

recommendations that vary by energy level, sex, and/or age. A total population score of less than 51 was considered poor, 51-80 needs improvement, and greater than 80 was good.

Intakes of energy, fatty acids, sodium, and alcohol were calculated using the Food and Nutrient Database for Dietary Studies, version 1.0 and 4.1 (USDA Agricultural Research Service), Food Surveys Research Group, 2012. Food group intakes were calculated using the MyPyramid Equivalents Database, version 1.0 (USDA Agricultural Research Service), Food Surveys Research Group, 2012 and the Center for Nutrition Policy and Promotion (CNPP) 2001-02 fruit database. Food group intakes were calculated using the MyPyramid Equivalents Database, version 2.0, CNPP's addendum to the database (Koegel and Kuczynski, 2011), and the CNPP 2003-04 fruit database. Average daily, long-term ("usual") intakes of the various HEI-2010 components were estimated using the population ratio method (167).

Assessment of Acculturation: Acculturation was measured using the previously validated SL-ASIA scale. The SL-ASIA scale is a 21-item multiple-choice questionnaire used to measure Asian American acculturation into Western culture. The scale was designed specifically for Asian populations yielding scores that delineate acculturation status on a unidimensional scale from 1-5 (109, 151). It covers language (4 items), identity (4 items), friendship (4 items), behaviors (5 items), generation/geographic history/enclave residence (3 items), and attitudes (1 item). A final acculturation score was calculated by dividing the total value by 21; a score ranging from 1.0-2.0 connotes low acculturation, reflecting high Asian identification, a score between 2.1-3.9 connotes biculturation and a score of 4.0-5.0, reflecting high Western acculturation or assimilation (109)**.** The total score has been shown to reflect the overall level of acculturation. Studies have shown that the final score is both reliable and valid, alpha coefficients range from 0.72-0.91(151, 154). Reliability studies show that the Cronbach's alpha

for the SL-ASIA scale for Asian Americans was between 0.91 and 0.88, reflecting high

reliability (109). A validity study showed that the SL-ASIA scores were significantly correlated

with demographic information hypothesized to reflect levels of Asian American identity (109).

For example, high SL-ASIA scores were associated with having attended school in the United

States over a longer period of time, during which time the SL-ASIA's Asian identity score would

have been reduced. There are also 5 multidimensional items scored on a likert scale. This

alternative scoring model for SL-ASIA classifies subjects into three categories: Asian low

acculturated (LA), bicultural and Western acculturated (WA) by measuring acculturation as a

multidimensional rather than a unidimensional construct (155).

Results

The total composite HEI2010 score for SA's was 73.3 ± 1.2. The minimum score was 66.3 and maximum was 80.4. The total fruit category was 2.8 ± 0.2 out of 5 possible points (**Table 12**), total vegetables was 5.0±0.0 out of 5 points, whole grains was 6.1 ± 0.3 out of 10 points. Fatty acid consumption score out of 10 possible points was 7.9 ± 0.4 and sodium 5.0 ± 0.2 out of 10 points. Males had a score of 71.9 ± 1.9 and women's score was 67.9 ± 1.2 (**Table 13**).

Age Group Patterns: Table 14 displays the total average calories consumed by males and females (ages 18-65 years and ≥ 66 years). Males consumed significantly more total calories, cholesterol, monounsaturated fatty acids, whole grains, and polyunsaturated fatty acids compared to females **Table 14.** SA males had a greater macronutrient consumption compared to females but the differences were not significant. We dichotomized SA's by age: younger males and females ages (18-65 years) and older (≥66 years). **Table 14** shows that older males consumed increased total calories and calories from carbohydrates and fats compared to younger males. They also consumed more than younger and older females. Younger males consumed the most calories from proteins compared to older males and females. Older females consumed the least total calories and calories from fats, carbohydrates, and proteins compared to the other three groups. Our results for age as a predictor variable with MetS and sex as class variables were as follows: Older SA males who were consuming increased total calories (2286 ± 596 calories) and calories from carbohydrates and fats (**Table 14**) had significantly increased MetS (55%) compared to younger males (2037 ± 595 calories) that had 28% MetS. The percent of MetS in older females (73%) also was higher compared to younger females (37%).

Ethnic Group Patterns: Bengali's consumed more sodium than all other groups, about 4649 mg of sodium, Indian (3542 mg) and Pakistani (3570 mg). Sodium consumption for Bengali's was significantly different from Pakistani (p=0.007) and from Indian (0.0055). Indian males consumed significantly more fiber than Indian females (**Table 15**) and Bengali females consumed 925 mg more sodium than Indian females (p=0.0394). Pakistani's consumed significantly more non-whole grain compared to Bengali's. The HEI2010 for Pakistani was 68.3 ± 1.7, Indian was 67.9 ± 2.7, Bengali was 68.6 ± 2.0, and Other SA was 66.2 ± 2.2 (**Table 16**).

Acculturation Patterns: The Asian LA group had a mean HEI2010 score of 68.7 ± 1.2 and the WA group was significantly different at 69.8 ± 2.2 (**Table 17**). WA group consumed increased total calories, calories from protein, calories from fat, and calories from carbohydrates compared to the Asian LA (**Table 18**). In the LA group, males and females were significantly different (**Table 18**). We looked at acculturation and MetS and found that low acculturated Asians had a greater percent of MetS (43%) compared to the WA (28%). The Asian LA males had greater obesity (WC ≥ 90cm) 67% compared to the WA males (33%). The Asian LA females had greater obesity (WC ≥ 80 cm) 83% compared to the WA females 17%.

Age Group and Acculturation Patterns: We dichotomized SA's by younger males and females ages (18-65 years) and older (≥66 years). **Table 14** shows that older males consumed increased total calories and calories from carbohydrates and fats compared to younger males. Younger males consumed more calories from proteins. Older females consumed the least total calories and calories from fats, carbohydrates, and proteins. The percent of MetS in older males and females was greater compared to younger males and females. The Asian LA group had 63% who were from the age group 18-55 years of age and 37% from age group 56-80 years. The WA group had 85% from age group 18-55 years and 15% from age group 56-80 years. Therefore,

majority of the age group 18-55 years of age were low acculturated 68% and 87% of the older

age group was LA. In the age group 18-55 years of age 34% had MetS and the age group 56-80

years of age 51% had MetS.

MetS Patterns: **Table 19** shows the macronutrients and micronutrient consumption comparisons

between those with MetS and without MetS. The results showed that subjects without MetS

consumed statistically more total calories, carbohydrates, and total fruits. Males with MetS

scored 67.9 ± 2.4 on the HEI2010 while males without MetS scored 73.2 ± 2.3 (**Table 20**).

Females with MetS scored higher 67.9 ± 1.5 compared to women without MetS 65.2 ± 1.7

(**Table 20**).

Discussion

This is the first study to examine the association of dietary habits coupled with acculturation on the burden of MetS among low-income SA's from diverse South Asian countries. Examining the dietary behavior of SA's we found significant differences among age groups with Older SA men consuming increased total calories (**Table 14**) and calories from carbohydrates and fat. These older SA men had a greater percent of MetS 55% compared to younger males 28%. The percent of MetS among younger males in this study was comparable to the results of MetS prevalence found in European Americans 22%. Older women also had a greater percent of MetS (73%) compared to younger females (37%). This increase of MetS among older males and females compounds the overall MetS percentage in this low-income SA population. We also found that the percentage of MetS was greater in this SA group (48%) compared to European Americans 22%, African Americans 23%, and Mexican Americans 32%.

We observed a higher percent of MetS in the Asian LA group compared to the WA. The calorie or macronutrient consumption among the WA versus the Asian LA groups (**Table 18**) was not very different. Asian LA consumed significantly more total vegetables compared to the WA. Additionally, Asian low acculturated males had greater consumption of calories compared to the Asian low acculturated females (**Table 18**). These results were surprising given that Garduno-Diaz study (N=100) male and females (>30 years of age), recently found that dietary acculturation including altered meal patterns may be associated with higher prevalence of MetS (self-reported dyslipidaemia and hyperglycaemia) in SA's in the U.K (168). This study had a small sample size with self-reported diabetes and dyslipidemia instead of direct measurements. They also used previously diagnosed T2D as a proxy for insulin resistance rather than direct measurements. Their study also had conflicting results where they reported that vegetarians have

115

higher rates of abnormal MetS indicators yet, a western pattern of diet including more meat was associated with MetS. In our study, the HEI2010 for Asian LA was significantly (P<0.001) lower (68.7 ± 1.2) than the WA group score 69.8 ± 2.2. The WA group was eating healthier with higher scores in the dairy 4.6 ± 0.4, seafood and plant proteins 4.7 ± 0.5, and refined grains 2.2 ± 0.7 (**Table 17**).

Dodani (111) also used acculturation as a tool for the analysis of coronary artery disease among 159 SA Indians (SAI) aged 35-65 years of age. The majority of SAI's (68%) were classified as high acculturated using the SUINN-LEW scale. However, our study had a majority of SA who were Asian or low acculturated. They were seeking to make associations between acculturation and Type II diabetes mellitus. Similar to our study, Dodani did not find significant correlations with acculturation status and disease. In our study, males were more Western acculturated than females but females had a higher prevalence of MetS.

The SA's overall received a score of 73.3 (**Table 12**) in the HEI2010 index. This implies that this population's dietary habits need improvement. A recent study on the U.S population showed that overall Nations men's diet quality (mean HEI2010 total score = 49.8) was poorer than women's (52.7), and younger adults' diet quality (45.4) was poorer than older adults' (56.1) (p<0.01). We found similar results showing that older adults (≥65 years) were consuming more calories, carbohydrates, and total vegetables compared to younger adults.

The males (HEI2010 score 71.9 ± 1.9) in this study were eating significantly (P<0.001) healthier than the females (HEI2010 score 69.9 ± 1.2). They has better component scores for greens and beans, whole grains, and refined grains (**Table 13**).

Gadgil(169) gathered dietary information from food frequency questionnaires on SA's in California and found that vegetarian diets were associated with lower insulin resistance

compared to Western diets. This study only looked at (n=150) Asian Indians aged 45-84 years. Vegetarian diet and Western diet categories were defined using principal component analysis.

In a recent review article, Perez-Escamilla, strongly suggested that "Latino immigrants arrive in the U.S. practicing healthier behaviors than their European American counterparts"(170). Perez-Escamilla also suggests that acculturation can have adverse health effects as well and this process of acculturation in Latinos may increase health disparities. On the other hand, acculturation is also associated with more income, more education, better access to healthcare, and better access to food, and better food choices. SA immigrants have the same positive and negative association with acculturation. In my study the Asian LA SA's had lower MetS percentage with lower HEI2010 scores. The dietary practices of these Asian oriented SA were not as healthy as the WA group.

Conclusion

The SA in this study were low-income Asian low acculturated who had an overall HEI2010 score of 73.3. Western acculturation was not associated with higher percentage of MetS. Older SA males (55%) and females (73%) had the highest percentage of MetS. Additionally, older males had the highest consumption of total calories and calories from fat and carbohydrates. These older males had been in the U.S. for the longest period of time but were still mostly Asian low acculturated. Younger males had the highest consumption of proteins. Older females that the highest percentage of MetS (73%) and had the lowest consumption of all macronutrients and key micronutrients. Asian LA status group had a greater percentage of MetS in males and females. The dietary intake of Asian LA subjects was not as healthy as the WA group of SA's. The total score males with MetS was lower than males without MetS and the opposite was true for the females in this study.

References

1. Misra A, Khurana L. Obesity and the metabolic syndrome in developing countries. The Journal Of Clinical Endocrinology And Metabolism 2008;93(11 Suppl 1):S9-S30.

2. Popkin BM. Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases. The American Journal of Clinical Nutrition 2006;84(2):289-98.

3. Misra A, Khurana L. Obesity and the Metabolic Syndrome in Developing Countries. The Journal of Clinical Endocrinology & Metabolism 2008;93(11_supplement_1):s9-s30. doi: 10.1210/jc.2008-1595.

4. Ram CVS, Farmer JA. Metabolic syndrome in South Asians. Journal Of Clinical Hypertension (Greenwich, Conn) 2012;14(8):561-5. doi: 10.1111/j.1751-7176.2012.00652.x.

5. Alberti KGMM, Eckel RH, Grundy SM, et al. Harmonizing the Metabolic Syndrome: A Joint Interim Statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. Circulation 2009;120(16):1640-5.

6. McGuire S. US Department of Agriculture and US Department of Health and Human Services, Dietary Guidelines for Americans, 2010. Washington, DC: US Government Printing Office, January 2011. Advances in Nutrition: An International Review Journal 2011;2(3):293-4.

7. Guenther PM, Casavale KO, Reedy J, et al. Update of the Healthy Eating Index: HEI-2010. Journal of the Academy of Nutrition and Dietetics 2013;113(4):569-80. doi: http://dx.doi.org/10.1016/j.jand.2012.12.016.

8. Flegal KM, Carroll MD, Kit BK, Ogden CL. PRevalence of obesity and trends in the distribution of body mass index among us adults, 1999-2010. JAMA 2012;307(5):491-7. doi: 10.1001/jama.2012.39.

9. Heart Disease and Stroke Statistics — 2010 Update. Dallas, Texas: American Heart Association, 2010.

10. Cholesterol Facts. In: Prevention CfDCa, ed.

119

11.   Alberti KG, Zimmet PZ. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus provisional report of a WHO consultation. Diabetic Medicine: A Journal Of The British Diabetic Association 1998;15(7):539-53.

12.   Britten P, Cleveland LE, Koegel KL, Kuczynski KJ, Nickols-Richardson SM. Updated US Department of Agriculture Food Patterns Meet Goals of the 2010 Dietary Guidelines. Journal of the Academy of Nutrition and Dietetics 2012;112(10):1648-55. doi: http://dx.doi.org/10.1016/j.jand.2012.05.021.

13.   USDA. internet.

14.   Suinn RM, Ahuna C, Khoo G. The Suinn-Lew Asian Self-Identity Acculturation Scale: Concurrent and Factorial Validation. Educational and Psychological Measurement 1992;52(4):1041-6.

15.   Suinn RM, Rickardfigueroa K, Lew S, Vigil P. The SUINN-LEW Asian Self-Identity Acculturation Scale - An initial Report. Educational and Psychological Measurement 1987;47(2):401-7. doi: 10.1177/0013164487472012.

16.   Reliability and validity of the Suinn-Lew Asian Self-Identity Acculturation Scale with Japanese temporary residents. Japan: Psychologia Society, 1995:17-21.

17.   Abe-Kim J, Okazaki S, Goto SG. Unidimensional versus multidimensional approaches to the assessment of acculturation for Asian American populations. Cultural diversity & ethnic minority psychology 2001;7(3):232-46. doi: 10.1037/1099-9809.7.3.232.

18.   Garduño-Diaz SD, Khokhar S. South Asian dietary patterns and their association with risk factors for the metabolic syndrome. Journal of Human Nutrition and Dietetics 2013;26(2):145-55. doi: 10.1111/j.1365-277X.2012.01284.x.

19.   Dodani S, Dong L. Impact of Acculturation on Coronary Artery Disease in the South Asian Immigrants-Unique Population with Increased Risk. Journal of Epidemiology and Community Health 2011;65:A237-A. doi: 10.1136/jech.2011.142976h.100.

20.   Gadgil MD, Anderson CAM, Kandula NR, Kanaya AM. Dietary Patterns in Asian Indians in the United States: An Analysis of the Metabolic Syndrome and Atherosclerosis in South Asians Living in America Study. Journal of the Academy of Nutrition and Dietetics 2014;114(2):238-43.

21.   Pérez-Escamilla R. Acculturation, nutrition, and health disparities in Latinos. The American Journal of Clinical Nutrition 2011;93(5):1163S-7S.

TABLES

Table 12: Estimated mean HEI-2010** component and total scores, expressed as absolute scores and as a percent of the maximum for adult South Asian American in 2 Community Health Centers in Maryland (N=400).

Component (maximum score)	Min	Max	Score Mean±SEM
Total Fruit (5)*	2.0	3.5	2.8±0.2
Whole Fruit (5)	3.2	5.0	4.4±0.3
Total Vegetables (5)	4.9	5.0	5.0±0.0
Greens and Beans (5)	5.0	5.0	5.0±0.0
Whole Grains (10)*	4.8	5.0	6.1±0.3
Dairy (10)	3.6	5.1	4.4±0.2
Total Protein Foods (5)	5.0	5.0	5.0±0.0
Seafood and Plant Proteins (5)	2.2	5.0	4.1±0.5
Fatty Acids (10)	6.6	9.6	7.9±0.4
Refined Grains (10)	3.8	5.9	4.9±0.3
Sodium (10)	2.2	7.9	5.0±0.2
Empty Calories (20)*	17.4	19.9	18.7±0.3
Total Score (100)	**66.3**	**80.4**	**73.3±1.2**

*The total score for total fruit is out of 5 possible points. The total points for whole grains are out of 10 points possible and the total points for empty calories are out of 20 points possible.
**Healthy Eating Index-2010: Scores ≤ 80 needs improvement.

Table 13: Estimated mean Healthy Eating Index-2010 component and total scores by gender, expressed as absolute scores and as a percent of the maximum for South Asian American in 2 Community Health Centers in Maryland**

Component (maximum score)	Females Score Mean ± SEM	Males Score Mean ± SEM	P-Value
Total Fruit (5)	5.0 ± 0.01	4.6 ± 0.2	0.001
Whole Fruit (5)	5.0 ± 0.1	5.0 ± 0.001	0.001
Total Vegetables (5)	2.6 ± 0.2	2.6 ± 0.3	0.99
Greens and Beans (5)	4.1 ± 0.4	4.2 ± 0.5	0.007
Whole Grains (10)	5.1 ± 0.4	6.2 ± 0.5	0.001
Dairy (10)	4.7 ± 0.3	3.5 ± 0.3	0.001
Total Protein Foods (5)	5.0 ± 0.1	5.0 ± 0.0	0.9
Seafood and Plant Proteins (5)	4.2 ± 0.5	3.6 ± 0.7	0.001
Fatty Acids (10)	9.0 ± 0.4	8.9 ±0.6	0.001
Refined Grains (10)	0.002 ± 0.01	1.4 ± 0.6	0.001
Sodium (10)	4.4 ± 0.4	6.9 ± 0.4	0.001
Empty Calories (20)	18.9 ± 0.5	19.9 ± 0.2	0.001
Total Score (100)**	67.9 ± 1.2	71.9 ± 1.9	0.001

*The total score for total fruit is out of 5 possible points. The total points for whole grains are out of 10 points possible and the total points for empty calories are out of 20 points possible.
**Healthy Eating Index-2010: Scores ≤ 80 needs improvement.

Table 14: Macronutrient Consumption and Metabolic Syndrome among South Asian Americans in Two Community Health Centers in Maryland Dichotomized by Age and Gender

	18-65 yrs.		66+ yrs.	
	Males	Females	Males	Females
Total Kcal (calories)	2037±595#	1742±593#	2286±596#	1540±596#
Carbohydrates (calories)	249±93	227±93	281±94	194±94
Total Fats (calories)	68±63ω	58±63 ω	73±62#	50±63#
Protein (calories)	108±52#	80±52#	106±52	69±51
MetS$^{\lambda}$ Prevalence	28%	37%	55%	73%

*micrograms, # P<0.001 significant between males vs. females, ω P=0.0160, $^{\lambda}$ Metabolic risk factors were defined according to the IDF harmonized definition: elevated triglycerides ≥150mg/dl or treatment for hypertriglyceridemia; reduced HDL cholesterol <40 mg/dl for men and <50 mg/dl for women or treatment for this lipid abnormality; elevated blood pressure ≥130 mmHg systolic and/or ≥85mmHg or treatment for previously diagnosed hypertension, elevated fasting plasma glucose ≥100 mg/dl or previously diagnosed T2D

Table 15: Energy, Cholesterol, Sodium, and Consumption Among Ethnic Groups from Pakistan, India, Bangladesh, and other South Asian Americans by Gender in Two Community Health Centers in Maryland

	Total Kcals	Protein	Carbs	Total Fat	Sat Fat	MUFA	Cholesterol	Sodium
Pakistan	1851.9							
Males N=106	1987±669	84±43	218±79	59±33	17±12	22±11	271±220	3626±1891
Females n=117	1716±650	80±35	212±89	60±30	17±9	23±12	235±180	3509±1589
India	1841.9							
Males n=34	1070±694	83±38*	242±94	66±31#	18±11	25±11@	249±196^	3785±1573
Females n=37	1613±614	66±33*	228±87	50±26#	14±8	18±11@	167±159^	3469±1588
Bangladesh	2122.6							
Males	2260±760	90±42	259±119	67±32	18±13	24±12	228±161	4344±1859
Females	1985±643	92±42	283±84	60±30	16±10	22±11	238±180	4955±1505
Other	1836.2							
Males n=16	1964±391	82±31	240±52	59±22	16±8	22±10	247±196	4332±1483
Females n=24	1708±572	71±33	233±81	50±26	14±8	18±11	150±117	3847±1650

Table 16: Estimated mean Healthy Eating Index-2010* Component and Total Scores by Ethnic Group for South Asian Americans in Two Community Health Centers in Maryland

	Pakistan	India	Bengali	Other SA	
Component (maximum score)	Mean ± SEM	Mean ± SEM	Mean ± SEM	Mean ± SEM	P-Value
Total Fruit (5)	4.7 ± 0.2	4.9 ± 0.2	4.9 ± 0.04	4.9 ± 0.007	P<0.001
Whole Fruit (5)	4.9 ± 0.02	4.9 ± 0.003	4.9 ± 0.01	4.9 ± 0.03	1.0
Total Vegetables (5)	2.5 ± 0.2	2.4 ± 0.3	3.0 ± 0.5	2.3 ± 0.5	P<0.05
Greens and Beans (5)	4.0 ± 0.4	3.9 ± 0.6	4.4 ± 0.6	3.9 ± 0.7	P<0.001
Whole Grains (10)	6.0 ± 0.4	6.6 ± 0.9	4.0 ± 0.8	4.5 ± 0.9	P<0.001
Dairy (10)	4.2 ± 0.2	4.6 ± 0.5	3.0 ± 0.5	3.9 ± 0.6	P<0.5
Total Protein Foods (5)	5.0 ± 0.1	5.0 ± 0.1	5.0 ± 0.0	4.9 ± 0.005	P<0.001
Seafood and Plant Proteins (5)	3.3 ± 0.6	1.8 ± 0.9	4.9 ± 0.08	4.6 ± 0.7	P<0.001
Fatty Acids (10)	7.5 ± 0.5	8.4 ± 0.8	8.9 ± 1.0	8.3 ± 1.1	P<.001
Refined Grains (10)	0.8 ± 0.5	0.9 ± 0.7	6.01 ± 0.09	0.006 ± 0.08	P<0.001
Sodium (10)	6.5± 0.4	4.6 ± 0.8	5.2 ± 0.7	3.6 ± 1.0	P<0.001
Empty Calories (20)	18.7 ± 0.4	19.7 ± 0.5	19.9 ± 0.08	19.9 ± 0.1	P<0.001
Total Score (100)**	68.3 ± 1.7	67.9 ± 2.7	68.6 ± 2.0	66.2 ± 2.2	P<0.001

*The total score for total fruit is out of 5 possible points. The total points for whole grains are out of 10 points possible and the total points for empty calories are out of 20 points possible.**Healthy Eating Index-2010: Scores ≤ 80 needs improvement

Table 17: Estimated Mean Healthy Eating Index-2010* Component and Total Scores by Acculturation, Expressed as Absolute Scores and as a Percent of the Maximum for South Asian Americans in Two Community Health Centers in Maryland

	Asian Acculturation (Score 0-1)	Western Acculturation (Score3-5)	
Component (maximum score)	Score Mean ± SEM	Score Mean ± SEM	P-Value
Total Fruit (5)	5.0 ± 0.01	4.1 ± 0.3	0.001
Whole Fruit (5)	5.0 ± 0.1	4.9 ± 0.02	0.001
Total Vegetables (5)	2.6 ± 0.2	2.4 ± 0.3	0.001
Greens and Beans (5)	4.3 ± 0.4	3.7 ± 0.5	0.001
Whole Grains (10)	5.8 ± 0.2	5.4 ± 0.6	0.001
Dairy (10)	3.9 ± 0.2	4.6 ± 0.4	0.001
Total Protein Foods (5)	5.0 ± 0.1	5.0 ± 0.1	0.9
Seafood and Plant Proteins (5)	3.3 ± 0.4	4.7 ± 0.5	0.001
Fatty Acids (10)	8.6 ± 0.4	6.7 ± 0.8	0.001
Refined Grains (10)	0.01 ± 0.04	2.2 ± 0.7	0.001
Sodium (10)	5.5± 0.4	6.1 ± 0.6	0.001
Empty Calories (20)	19.6 ± 0.3	19.7 ± 0.4	0.0006
Total Score (100)**	68.7 ± 1.2	69.8 ± 2.2	0.001

*The total score for total fruit is out of 5 possible points. The total points for whole grains are out of 10 points possible and the total points for empty calories are out of 20 points possible.**Healthy Eating Index-2010: Scores ≤ 80 needs improvement

Table 18: Macronutrient Consumption by Acculturation Status of South Asian Americans by Gender in Two Community Health Centers in Maryland

	Western Acculturated			Asian Low Acculturated		
	Total	Males	Females	Total	Males	Females
Total Kcal (N)*	1908	2055¥	1761	1871	2027^	1715¥^
Protein *	96	104$	89	93	109@	77@$
Total Fat*	125	66	59	125	68#	57#
Carbohydrates*	115	120	110	112	118	111
Total Vegetables!	1.8±1.2			1.5±1.1		

¥(p<0.0011), ^(p=0.0002), @(P<0.0001), $(P=0.0052), #(0.0243)
*measured in calories
! measured as total mean ± sd was statically significant at 0.0309

Table 19: Comparison of Key Nutrient Intakes for subject with and without Metabolic Syndrome in South Asian Americans in Two Community Health Centers in Maryland

	Metabolic Syndrome Not Present	Metabolic Syndrome Present
Variable	MEAN ± SEM	MEAN ± SEM
Total Fruit	0.89 ± 1.2*	0.62 ± 0.8*
Sodium	3687.4 ± 1621	3862.6 ± 1860

*P=0.008

Table 20: Estimated Mean Healthy Eating Index-2010* component and total scores of Metabolic Syndrome for South Asian Americans in Two Community Health Centers in Maryland by Gender

	Males with MetS	Females with MetS	Males No MetS	Females No MetS
Component (maximum score)	Mean ± SEM	Mean ± SEM	Mean ± SEM	Mean ± SEM
Total Fruit (5)	4.6 ± 0.3	5.0 ± 0.001	4.5 ± 0.3	4.9 ± 0.05
Whole Fruit (5)	4.9 ± 0.2	5.0 ± 0.01	4.9 ± 0.03	4.9 ± 0.02
Total Vegetables (5)	2.4 ± 0.3	2.0 ± 0.3	2.8 ± 0.4	3.2 ± 0.4
Greens and Beans (5)	3.9 ± 0.6	3.1 ± 0.5	4.4 ± 0.6	4.8 ± 0.4
Whole Grains (10)	7.0 ± 0.7	5.6 ± 0.5	5.5 ± 0.7	4.5 ± 0.5
Dairy (10)	3.4 ± 0.3	4.5 ± 0.3	3.7 ± 0.4	4.8 ± 0.4
Total Protein Foods (5)	5.0 ± 0.1	5.0 ± 0.1	5.0 ± 0.001	5.0 ± 0.001
Seafood and Plant Proteins (5)	2.4 ± 0.5	4.5 ± 0.6	4.3 ± 0.8	3.7 ± 0.7
Fatty Acids (10)	7.3 ± 0.8	8.9 ± 0.6	8.5 ± 0.9	7.0 ± 1.6
Refined Grains (10)	0.4 ± 0.5	.003 ± 0.01	2.8 ± 0.8	0.01 ± 0.09
Sodium (10)	7.1 ± 0.6	5.1 ± 0.6	6.8 ± 0.6	3.5 ± 0.6
Empty Calories (20)	19.4 ± 0.6	19.1 ± 0.5	19.9 ± 0.09	18.7 ± 0.7
Total Score (100)**	67.9 ± 2.4	67.9 ± 1.5	73.2 ± 2.3	65.2 ± 1.7

*The total score for total fruit is out of 5 possible points. The total points for whole grains are out of 10 points possible and the total points for empty calories are out of 20 points possible.**Healthy Eating Index-2010: Scores ≤ 80 needs improvement

Chapter 5 Summary and Implications/Conclusions

A) Summary

The studies in this paper were to determine the overall percent of MetS and the components that define MetS in a cross section of low-income SA Americans who utilized two community health centers in Maryland. We examined the association of MetS prevalence in this survey group among men and women, the association of MetS prevalence among SA ethnic groups, the indicators of MetS by gender and ethnic groups, the percentage of MetS using different markers for obesity (Waist circumference vs. body mass index), the variables that predict having MetS by gender and ethnic groups. We also evaluated the acculturation status as a predictor of MetS by gender and ethnic groups, and the HEI2010 score for the population. We also calculated the HEI2010 score by gender, acculturation status, MetS status, and by ethnic group.

The percent of MetS among low income SA Americans in these two community health centers in Maryland was greater compared to European Americans, African Americans, and Mexican Americans prevalence studies in the U.S. MetS studies have been controversial due to the varying definitions. Strengths, of my study, included the use of the new consensus harmonized definition for analyzing the percent of MetS for this SA group. Another strength, was the large SA sample size (N=1401) with many countries from SA in our study (Pakistan, Bangladesh, India, Nepal, Sri Lanka, and others). We were able to show that the recommended WC cut offs for SA's (≥90 cm for men, 80 cm for men) yielded a similar MetS percent as using the WHO BMI recommendations for a diverse SA sample. We were able to show that the recommended WC cut offs for SA's (≥ 90 cm for males, ≥ 80 cm for female) yielded a similar MetS percentage as using the WHO BMI recommendations for a diverse SA sample.

131

Studies on SA have focused on Asian Indians in the U.S., in this paper, were able to compare the patterns of MetS indicators in previously unstudied SA ethnic group. Asian Indians had a greater percentage of abnormal fasting blood glucose coupled with abnormal HDLC. However, Pakistani, Bengali, and Other SA had an increased abnormal HDLC coupled with triglycerides.

Consideration of acculturation in the context of health studies has been initiated after noting that acculturation influences lifestyle and health behavior in migrant communities and has been shown to be associated with risk factors in chronic health diseases. SA's in our sample were largely Asian low acculturated who were low-income and utilized community health clinics in Maryland. The odds of developing MetS were higher for women, those with increased obesity, and decreased minutes of exercise. A third strength of this study was taking into account the cultural practices and acculturation levels relating to disease outcomes. We found that the Asian LA group in our survey presented MetS in similar percentages to that have been reported in SA developing countries.

Males were in the U.S for a longer time period (years) and had more education (years) compared to females but had decreased MetS compared to females. Low acculturated Asian males and females had an increased percent of MetS compared to Western acculturated Asians yet we would expect to find greater MetS in the Westernized Asians. The obesity prevalence was higher in the Western acculturated groups compared to the overweight and normal weight subject in the same acculturation levels. Males had a healthier diet and were more acculturated compared to females.

The Asian low acculturated group may be presenting disease patterns similar to their Asian ancestors in South Asia. The prevalence of disease was higher among the Asian low acculturated immigrants and it may be that the Western influence had not been the reason for the increase in the burden of disease among this population.

The HEI2010 composite score for this low-income SA population was 73.3 indicating an inadequate diet. A qualitative analysis of the dietary patterns revealed that SA's were consuming a monotonous diet consisting mainly of tea, rice, chicken and beef curries, whole grain roti and white bread. The vegetables that were consumed were also cooked in the form of a curry and fast food consumption was not a regular part of the diet. Many people reported consuming home cooked foods for lunch and dinner instead of purchasing fast foods.

Older SA males consumed the most total calories and calories from carbohydrates and fats compared to younger SA males, younger females, and older females. The prevalence of MetS among older SA males and females was increased and caused the overall prevalence of MetS increase. Older SA's had been resident in the U.S. longer and were more Western acculturated. We expected the older males and females to have increased prevalence of MetS but not to the extent we observed in this population. In fact, the overall prevalence of MetS in SA would be similar to Mexican Americans if we removed the older cohort of SA's (≥65 yrs. of age).

B) Implications and Conclusions

The nutritional transition that currently occurs in developed countries increases the burden of disease among the rural populations compared to the urban. In the U.S., the opposite is true, where the burden of chronic disease has been greater among the urban populations rather than the rural. The low income SA's in Maryland may have experienced a similar transition of wealth upon migration from rural SA to rural Maryland or urban Maryland. Further evaluation of this transition in this SA population is needed.

This study provided a basis for interesting results and new questions regarding MetS, acculturation, and diet among a group of SA's in Maryland that utilized two community health centers. This group of diverse low income SA's had not been previously investigated. An evaluation of the patients in these two clinics was important because the health outcomes for MetS may require hospitalizations due to heart failure, strokes, and other related complications. These hospitalizations of non-insured individuals cost tax payer's money that could be better allocated for targeting education programs. Nutrition education and lifestyle alteration in the low-income SA ethnic groups would be an important step towards the reduction of the burden of diseases. We are still in need of representative data on SA Americans in the U.S. to better assess the prevalence of MetS.

Since SA tend to have a high rates of obesity in developing countries, the WHO have lowered the cut-off values for SA's that enabled health care providers to diagnose and treat a greater number of patients for metabolic related illnesses. A greater number of SA's have been diagnosed with MetS due to the decrease in WC and BMI cut off values. This study provided baseline percent of MetS using the latest consensus harmonized definition in a group of SA's

134

from Pakistani, Bangladesh, India, other SA countries. This study further confirmed the use of WHO BMI cut off values for SA's in the development of MetS.

MetS increases CVD and T2D two-fold to three-fold in some studies. SA's in this survey presented a very high percent of MetS. Additionally, this study investigated the MetS differences between people from Pakistan, Bangladesh, India, Sri Lanka, Nepal, and other SA countries. This study also looked at the clustering of MetS components for each of the SA's ethnic groups mentioned above and found that HDLC was the most common abnormal indicator. HDLC and triglycerides were the two most common abnormal indicators and HDLC, triglycerides, and fasting blood glucose were the three most common abnormal indicators. This pattern was slightly different for Asian Indians (HDLC and fasting blood glucose were the two most common abnormal indicators). Other studies on Asian Indians have suggested similar results. We may need to further investigate why Asian Indians have a different pattern of abnormal indicators compared to other Asians.

Acculturation status showed that this group of SA's as a whole were low acculturated, had a higher percent of MetS compared to the Western identified group, and had lower HEI2010 mean scores. We expected that the LA group would have had a healthier diet and less MetS compared to the WA group because western diets have been labeled as "fast-food diets" with increased saturated fat intakes, and less fiber from fresh fruits and vegetables. The Western lifestyle has also been labeled with having a lack of time for food preparation and exercise. This study group defined as WA by the SUINN-LEW presented a healthier diet and lower percent of MetS. It may be that the SUINN-LEW acculturation scale is not a good measure of lifestyle habits associated with diseases in various groups of SA. The validity of this measure should be investigated further and compared in various SA ethnic groups.

A closer look into the progression of disease from host countries including ancestral habits of SA's may elucidate how diseases and health complications such as abnormal HDLC, triglycerides, and fasting blood glucose levels develop over generations. Migration studies on SA's tracking the progression of chronic disease would prove to be extremely helpful with implications in other populations.

The lack of effective dietary measurement tools such as being able to include cultural dishes for SA's may also present further barriers for precise calculations related to diet. The most current, up to date version of the National Health Food Database that was used in this study did not include accurate foods and recipes had to be added for dietary evaluation. We found a low HEI2010 score of 73 for this group which needs improvement but it was still higher than European Americans and African Americans (who have mean scores in the 50's).

The case studies brought up further questions that need to be asked about SA food pathways, behaviors, and habits. We need to have a better understanding of what foods SA consider being healthful and harmful to health. We do not yet know the reasons behind why SA develop disease at much younger ages and at very high percentage compared to other ethnic groups. We also do not completely understand how migration affects SA's dietary and health habits and how a new environment plays a role with MetS. We need a better understanding where SA's receive health and diet information and who is considered a credible source for this population. The SA's that lived in the U.S for less or equal to five years were consuming breakfast foods that included milk and tea compared to those who reside in the U.S. for more than 5 years consumed American breakfast cereals and oatmeal. Those residing in the U.S. for less than five years were also more likely to consume all of their leftovers and the males were more likely to drive home for a meal instead of eating fast foods. SA's who have been in the U.S. longer were more likely to eat fast

foods or eat out. It would also be very interesting to further investigate the concept of healthy foods in the SA culture. Future studies should focus on the cultural understanding of the role of consuming meat that has not been slaughtered according to Islamic standards and the decision making related to consuming or not consuming foods at fast food restaurants.

SA males had a healthier diet compared to females and the question of how food is allotted differentially in the SA culture would be very interesting. Many cultures have witnessed that males received preferential treatment towards food and the quantity of food. This was the case in the SA groups that we studied. The demand for food in a household has been different when males have been a part of the household compared to absent of household and important in the role of food and disease. Future studies on the demand for food and how food was divided among males, females, and children would be interesting.

Studying groups in the U.S. such as those represented by the data in this study from two community health centers was an important step in moving away from the dominant paradigms that exist related to disease. The complexity of issues related to disease, culture, and diet are important to investigate in the context of each ethnic group separately in order to tease out the significant risk factors. The cultural and dietary patterns of Indians are likely to be very different from the cultural and diet patterns of the other SA ethnic groups. However, most of our inferences about SA are drawn from Asian Indians. This study shows that many of these generalizations about SA from SA Indians may not be valid for all SA Americans.

Education programs targeting all age groups about the importance of a healthful diet and regular exercise may be necessary in combating chronic diseases in this population. Additionally, finding culturally appropriate and acceptable forms of exercise and foods may also be important.

Appendix

HEI–2010[1] Components & Scoring Standards			
Component	**Maximum points**	**Standard for maximum score**	**Standard for minimum score of zero**
Adequacy:			
Total Fruit[2]	5	≥0.8 cup equiv. per 1,000 kcal	No Fruit
Whole Fruit[3]	5	≥0.4 cup equiv. per 1,000 kcal	No Whole Fruit
Total Vegetables[4]	5	≥1.1 cup equiv. per 1,000 kcal	No Vegetables
Greens and Beans[4]	5	≥0.2 cup equiv. per 1,000 kcal	No Dark Green Vegetables or Beans and Peas
Whole Grains	10	≥1.5 oz equiv. per 1,000 kcal	No Whole Grains
Dairy[5]	10	≥1.3 cup equiv. per 1,000 kcal	No Dairy
Total Protein Foods[6]	5	≥2.5 oz equiv. per 1,000 kcal	No Protein Foods
Seafood and Plant Proteins[6,7]	5	≥0.8 oz equiv. per 1,000 kcal	No Seafood or Plant Proteins
Fatty Acids[8]	10	(PUFAs + MUFAs)/SFAs >2.5	(PUFAs + MUFAs)/SFAs <1.2
Moderation:			
Refined Grains	10	≤1.8 oz equiv. per 1,000 kcal	≥4.3 oz equiv. per 1,000 kcal
Sodium	10	≤1.1 gram per 1,000 kcal	≥2.0 grams per 1,000 kcal
Empty Calories[9]	20	≤19% of energy	≥50% of energy

1: Intakes between the minimum and maximum standards are scored proportionately.
2: Includes fruit juice.

3: Includes all forms except juice.

4: Includes any beans and peas not counted as Total Protein Foods.

5: Includes all milk products, such as fluid milk, yogurt, and cheese, and fortified soy beverages.

6: Beans and peas are included here (and not with vegetables) when the Total Protein Foods standard is otherwise not met.

7: Includes seafood, nuts, seeds, soy products (other than beverages) as well as beans and peas counted as Total Protein Foods.

8: Ratio of poly– and monounsaturated fatty acids to saturated fatty acids.

9: Calories from solid fats, alcohol, and added sugars; threshold for counting alcohol is >13 grams/1000 kcal.

National Cancer Institute appliedresearch.cancer.gov/tools/hei/developing.html

IV.   South Asian American Food Pathways Study: Individual Case Studies

Abstract: The U.S. is a diverse country that includes several cultures of people separated by geographical, social, historical, and demographic patterns. South Asian (SA) Americans in the U.S. present patterns of behavior that are both similar to their country of origin as well as the host country to where they migrate. In our study, we used qualitative analyses to further evaluate the process of acculturation and the food pathways of this migrant population. The objective of the case studies was to evaluate SA's cultural adaptations related to eating, snacking, and shopping habits. Describe the personal and immediate household and network food behaviors. Assess parental household behaviors and differentiate their children's household behaviors. We used in depth interviews at two community health centers in Maryland. Our sample consisted of 16 individuals in the field, speaking English, Panjabi, Hindi, and Urdu language with subjects, and went to the places where they shopped and frequented. We alphabetized the case studies using each subject's self-selected pseudonym.

Background

South Asian (SA) Americans are the fastest growing minority group in the U.S. after Mexican Americans. SA's in the U.S. have high socioeconomic status (Doctors, Lawyers, Engineers, and Business Owners), middle class status (working in white and blue collar jobs) and lower class status (working minimum wage jobs, on welfare, and/or being supported by family members). SA's come from many countries including: India, Pakistan, Bangladesh, Nepal, Sri Lanka, Iran, etc. Much research focuses on wealthy Asian Indians from one South Asian country and usually higher socioeconomic status. Many SA's have migrated to the U.S. for better educational and economic opportunities. SA's in their host countries may be upper, middle, and lower socioeconomic class and that situation changes upon arrival to the U.S. Lack of social support networks, migration, and acculturation may work together and these SA's may have additionally, gone through a nutritional transition prior to arrival to the U.S. Traditional research methods and analyses may not properly quantitate the prior situation as well as the post migration status. For this reason, qualitative analyses may help to generate further research questions regarding complicated questions such as cultural practices related to diet and disease by using open ended answers by subjects. We interviewed 16 SA Americans attending community health care services as a part of the South Asian American Health Initiative (SAAHI) from June 2011 to December 2013. All research was approved by the University of Maryland, Internal Review Board for human subject research and patients signed an informed consent. The subjects were first asked to create pseudonyms and a series of questions (see appendix) were asked to generate discussions.

We selected individuals on a voluntary basis. These volunteers were selected based on their country of origin and years residing in the U.S. Our sample consisted of four subjects each

141

from; India, Pakistan, Bangladesh, and Other SA. From each country, two subjects resided in the U.S. for less than five years, and two subjects resided for more than five years. The final analyses had 4 subjects from India (2 resided in the U.S. for more than five years, and 2 resided in the U.S. for more than five years), and the same from Pakistan, Bangladesh, and Other SA countries for a total of 16 interviews.

1. Aminah from Bangladesh, residing in the U.S. greater than 5 years.

Personal and Immediate Household and Network: At the time of the interview (6/15/2011), Aminah was 42 years old and single. She was born in Philadelphia, Pennsylvania and was raised in Bangladesh where she moved from the age of 5 years until the age of 18. Other than her immediate family (sisters and mother) everyone was in Bangladesh. Her father "passed away from heart disease while she was in Bangladesh". She has "not traveled to Bangladesh for 20 years". She worked for a finance company earning a middle class income and lived in Montgomery County.

Her community had a "sizeable proportion of people that share the same background such as her neighbors including immediate neighbors". Beyond her neighborhood, Aminah was "very integrated within the community and with people of the same ethnicity". She communicated with "Bengali's every week or every two weeks in social events, family gatherings and shopping". There were "no Bengali's at her place of employment" or where she engaged in exercise.

Food and Shopping Behaviors: When shopping she "very rarely purchased foods preferred by members of her community". Some of the ethnic foods she purchased were from "Bangla Bazar including: masala, daals (lentils), rice, snacks called channa chu (hot mix)". The foods that were

included in a routine week day meal in her household "for lunch time were: pasta, bean salads, sandwiches such as egg salad and tuna salad". A typical dinner included: "veggies, daal, curry, and white or brown rice". On weekends, "the meals were typically different with more eggs being served for breakfast compared to cereal during the weekdays". Lunch of weekends contain "sweet potatoes or small snacks and dinner was larger with fish or pasta and she typically cooked more on weekends but not necessarily more ethnic foods". On holidays, special feast and other festive occasions there were different foods served including Biryani (meat and rice), Curry, and fried samosas. Sweets included shimari (thin wheat noodles cooked in milk, sugar and butter). Aminah usually did not snack between her meals but snacking included fruits and nuts. Parental Household: In a routine weekday meal in the household where she grew up it was not very different than what Aminah consumes now. Typical foods included: pasta with veggies, Kabobs (meatballs), potatoes, and eggs. Previously, more curry was being served compared to increased fruits and vegetables now. Lastly, Aminah claimed that more awareness of health issues had caused her to change eating habits because of sicknesses. In order to prevent illness she consumed "healthier" food items.

Dietary behavior of children: Aminah does not have any children

2. Bob from Bangladesh, residing in the U.S. more than 5 years

Personal and Immediate Household and Network: Bob grew up in Pakistan and Bangladesh and was currently 49 years old at the time of interview (8/15/12). He migrated to the U.S. at the age of 21 and did not attend school in the U.S. at all. He still had many relatives both immediate and distant in Pakistan and Bangladesh. He traveled there every other year, and the last time was 2011. He resided in Anne Arundel County, was not employed, and was married with children.

Bob resided very close to a community center and his brother in law lived in walking distance. There were also two other families that live nearby in the community. Additionally, he regularly attended the prayer hall.

Food and Shopping Behaviors: When shopping he purchased foods preferred by Pakistani's very often. He shopped at Indus Foods about 2-3 times a week and Giant Food Store other times for items such as bread, eggs, and cereal. The typical ethnic foods purchased more frequently included: biryani masala mix (spices), frozen ethnic foods, naan (bread), and puri (roti bread). He also shoped at Kashmir Bazar for halal (slaughtered according to Islamic law) meat and whole wheat flour used to make roti (bread). A routine week day meal consisted of tea with milk with slice of bread or puri or cereal with milk at times. All lunches and dinners included Pakistani foods like rice with lentils and chicken or beef curry. Additional items included curried vegetables, yogurt, and roti. The weekend meals were exactly the same as weekday meals. On holidays, special feasts, and other festive occasions such as Eid the foods were different including more sweets such as rasmalia (ricotta cheese type of milk fat cooked in milk and sugar) and Bengali sweets and other special sweets from Aladeen and Bangla Bazaar. Bob snacked twice between breakfast and lunch. He drank milk tea, crackers, channa chur (hot trail mix), and mur mura (puffed rice) fried with onion and green chilli.

A routine week day meal in the household growing up consisted of the same food eaten today in front of the TV watching a Pakistani show. Fast food was not consumed growing up and it was not a major part of meals in his current dietary situation.

Dietary behavior of children: The meals changed when Bob had children. He had three children ages 13 years, 12 years, and 5 years old. They ate very different foods compared to the parents. They did not prefer to eat curries and ethnic foods, instead they liked sandwiches,

cereals, and pasta's. Bob believed that his children's food behaviors were affected by the outside environment, school lunches and greater independence for the 13 and 12 year old. They preferred to snack on sandwiches, cookies, and snacks that were purchased from Giant. The five year old also mimicked their older siblings.

3. Ciera from Pakistan, residing in the U.S. more than 5 years.

Personal and Immediate Household and Network: Ciera grew up in Pakistan until the age of 18 and then she moved to the U.S. with her husband. She was 54 years old on the date of interview 12/10/12. Her immediate family including brothers, sisters, and parents resided in Pakistan. Most of her in-laws were also in Pakistan. Her community did not have a sizable proportion of people of the same ethnic group and she was not very integrated into the religious community either. She did not travel back to Pakistan very often but the last time was about 5 years ago when her mother passed away. Recently, she had met a new Pakistani family that moved very close to her neighborhood. Ciera socialized with her children who live in the area and that was most of her contact with people of the same ethnic background.

Food and Shopping Behaviors: Ciera had to travel about 45 minutes away to purchase ethnic groceries to prepare Pakistani food. She purchased ethnic groceries about once a month and other times visited local grocery stores. Her typical routine week-day meal consisted of cereal, oatmeal, eggs, and waffles for breakfast. She did drink milk tea between breakfast and lunch and often had some milk tea during breakfast. For lunch, she usually ate left-overs and seldom cooked ethnic foods. Lunch foods included: sandwiches, salads, and pasta. For dinner her husband preferred Pakistani food so she cooked curry, lentils, and vegetables. The week-day meals were similar to weekends unless she had company over. She was not restricted to ethnic

foods because she did make tacos, lasagna, baked chicken, turkey and barbeque on the grill. Other foods also included hot dogs, and non-ethnic foods. For holidays, she usually cooked ethnic foods such as biryani, curry, and samosa. Dessert foods included: cakes, cookies, and pies but not ethnic desserts. Ciera's typical snacks throughout the day included: fruits, vegetables, nuts, and other non-ethnic foods. Her parent's consumption patterns were very different than what she consumed. Her parents only cooked Pakistani food but did eat a lot of fresh fruits.

Dietary behavior of children: Ciera had six children who ate foods very different from her. During the time her children were younger they consumed the foods that she cooked at home but when they became more independent, they preferred sandwiches, hotdogs, fast foods, and other American foods. Her children were 34, 31, 27, 24, 22, and 18. A typical breakfast included: cereal, pancakes, peanut butter jelly sandwiches, and pop tarts. Lunch and dinner were very similar to her parents.

4. Dina from Pakistan, residing in the U.S. more than 5 years

Personal and Immediate Household and Network: Dina was born and grew up in Pakistan and had been in the U.S for 25 years. She was currently 49 years of age as of the date of the interview (9/15/2012). She still had many immediate, extended and in-law family members in Pakistan. For the first 15 years in the U.S. Dina visited Pakistan every year. For the remainder of time she had been visiting about every 3 years. Currently, she resided in Prince George's County, in a community without a sizeable proportion of people of the same ethnic background. She described her community as a mix of East Asian Americans, European Americans, and African Americans. She was not very integrated with SA's besides her family and a few friends with whom she socialized for special occasions such as birthdays and religious holidays.

Food and Shopping Behaviors: Dina purchased her groceries from Indus Groceries twice or three times a month in Montgomery County near the community center this data was collected. The most frequent foods purchased included; meat (slaughtered according to Islamic law), daal (lentils), spices, and spice mixes for foods such as biryani, haleeem (meat cooked for a long time with lentils and spices), and fish fry. A routine week-day meal consisted of western foods for breakfast such as cereals, oatmeal, and bagel. Lunch was also more flexible, but dinner was always Pakistani food including: curries, roti, rice, yogurt, and lentils. Dina's husband insisted on consuming ethnic foods for dinner and on weekends. She and her sister enjoyed cooking pasta and making sandwiches for lunch during the weekdays. On holidays, special feasts, and other festive occasions, Pakistani food was always consumed including: nehari (lentils and meat cooked like a thick soup), haleem, Korma (curry), Kabobs, biryani, and other foods. Dessert foods included: savia (thin wheat noodles cooked in milk and sugar), halwa (cream of wheat with cardomen and sugar), and cream brule. Dina snacked in between lunch and dinner about 4 to 5 times a day. These foods included: chips, breadsticks, chura (Pakistani dried chex mix), samosa, fruits, and vegetables. Meals at her parents' home were not very different than what she consumes today but the timing of the meals were different. Her parents always consumed 4 proper meals including: breakfast, lunch, tea, and dinner.

Dietary behavior of children: Dina had one son, 18 years of age. He consumed meals very similar to the mother and she never cooked separate meals for him ever since he was a baby. The only difference was that her son did not consume coffee like her and he liked to snack on different foods. He consumed a lot of milk, and generally was very fond of fluids including; water and Gatorade. He also loved sweets and desserts after meals. He played sports and loved to drink milk best of all.

5. Emma from India residing in the U.S. more than 5 years

Personal and Immediate Household and Network: At the time of the interview (8/15/2011), Emma was 26 years old and grew up in India until she was the age of 16. She migrated to the U.S. at 16 years of age and had been in Montgomery County, Maryland since that time. Emma had immediate and distant relatives that lived in India. In the past, she used to travel every two to three years and now much less often. The last time she went to India was about 5 years ago. She lived in a community and religious center that had a sizeable proportion of people from India and she was very integrated.

Food and Shopping Behaviors: Emma had the primary responsibility of shopping for the household. She shopped at the Indian grocery markets every week for daals (lentils), spices, cake rusks, tea, and meat. Her husband also preferred to eat Indian food in the evenings and on the weekends. The typical foods during the weekday and weekend were very similar for Emma. She also integrated pasta and other mixed meals upon the request of her children. At times the children requested hot dogs, chicken nuggets, and other non-Indian food items. She also shopped at Giant, Safeway, and other grocery stores as needed. She found the Korean stores to carry the cheapest produce with a lot more variety. The typical dinner foods in Emma's household included rice, chicken, beef kabobs, curries, cooked curried vegetables. She cooked with oil and Indian spices. She usually had tea between lunch and dinner and also a snack between lunch and dinner. Her snacks consisted of fresh fruit including banana, apples, orange, and pears. During holidays her family was very extravagant and they would spend a lot of money on sweets and fancy meal items such as biryani, nihari, and haleem.

Dietary behavior of children: Emma had two children aged 2 years and 6 years of age. Her oldest child was in first grade and her 2 year old was at home. She packed her child's lunch on a

regular basis including sandwiches, fruit, chips, cookies, and juice. Her oldest child enjoyed McDonalds French fries and chicken nuggets while the youngest child enjoyed consuming the foods Emma cooked including: rice and cooked vegetables. Both of her children did not like spices. At times the oldest child would give Emma a very hard time with foods that she cooked at home.

6. Frank from India, residing in the U.S. more than 5 years

Personal and Immediate Household and Network: Frank was 42 years old at the time of the interview and had been in the U.S for 14 years. He was born in India and came to the U.S at the age of 28 years old. He was married to an Indian woman at the age of 30 and divorced after 3 years. Then he had a second Jamaican wife from Jamaica and divorced her after 2 years. Frank was not very integrated into the Indian or Asian community and did not have many Asian's living close by in proximity to this home. He was not a part of the religious community either in Baltimore County. Frank did not travel to India for the past 15 years and did not have any travel plans. Frank had grandparents in India but his parents, brothers, sisters, aunts, uncles, and cousins were in the U.S. Some of them were in Maryland while some in other parts of the country.

Food and Shopping Behaviors: Frank had gone through many transitions in the past 5 years. He worked in construction so he did not consume typical meals during the weekday or weekend. He did not eat consistent meals and consumed meals very late at night. He ate out many times when he wanted to consume Indian foods. He enjoyed the buffet style meals from Lal Qila in Baltimore the best. He also enjoyed eating halal fried chicken as well. He also enjoyed eating from fast food restaurants. He did not shop at Asian stores very often but he did when he was married to his Indian wife. He also shopped at the Jamaican stores when his wife cooked foods

from those countries. He only shopped at Giant and Safeway for items such as cereal, milk, bread, deli meats, frozen foods, and produce.

Dietary behavior of children: Frank's children did not reside with him and he was not sure whether they were consuming Indian food or other types of foods.

7. Ghazalla from Sri Lanka, residing in the U.S. more than 5 years

Personal and Immediate Household and Network: Ghazalla was born in Chicago, Illinois and was 37 at the time of the interview. She resided in Howard County with her husband and two children. She had been living in the U.S. for her entire life. She had not been to Sri Lanka for the past 20 years and did not plan travel there. Her children had not yet seen their grandparents who lived in Sri Lanka. Her parents decided to move back to Sri Lanka before her children were born. She also has other family members in Sri Lanka.

Ghazalla was highly integrated into the Asian community and was an active member in her community. She was a Buddhist and belonged to a temple. In her immediate area she knew one other family of Asian descent. She was familiar with many Asian families who attended the temple.

Food and Shopping Behaviors: Ghazalla often shopped at the Indian grocery stores for spices and daals (lentils). Her family was vegetarian so they did not consume any meat but they did consume eggs. She said the Indian stores were the best places to buy lentils and that was what she did. Other grocery supermarkets were utilized for the remaining groceries. She consumed three meals a day with no snacks in between meals. Her biggest reason was due to lack of time to eat a snack.

Dietary behavior of children: Ghazala's children were ages 8 and 13. Even though Ghazalla was trying to raise her children as vegetarians, they did consume meat at school. She did not

pack their lunches from home and her children consumed food at school. On the weekends they consumed what she cooked including a lot of vegetables, but on the weekdays their food consumption was different. They preferred to eat American foods more than the parents including sandwiches, burgers, fries, hot dogs, and chips.

8.   Humaya from Nepal, resided in the U.S. more than 5 years:

Personal and Immediate Household and Network: Humaya was 50 years of age at the time of the interview and he has been in the U.S for 15 years. Humaya had not traveled to Nepal for the past 10 years. He was married with 4 children and also has extended family in his home. He resided in Montgomery County and his parents also lived with him. He had much extended family in Nepal including brothers, sisters, cousins, nephews and nieces. He lived in a community that had many other Asians such as Indians, Pakistanis and other Nepalis. He had been a part of the community and his children were also integrated in the Asian community.

Food and Shopping Behaviors: Humaya had been responsible for most of the shopping in the home. He mentioned Desi Corp and Spicy Mart and two of the main grocery stores the family utilized for food. The family also visited local grocery stores such as Safeway, Giant, and Shoppers. His wife was usually the one who bought groceries from the American supermarkets. The foods that they purchased from the Asian grocery stores included spices, meats, lentils, sweets (gulam zaman), rice, whole wheat flour and fresh vegetables.

The family liked to eat Asian foods most of the time including eggs with paratha for breakfast, rice and curry for lunch with vegetables, and roti with curry for dinner. The curries were made of goat, beef, chicken, and fish. Humaya tried to eat fish at least twice a week. He deemed it more healthful to consume fish. The adults did not consume cold cereals for breakfast but they did consume cream of wheat and oatmeal with milk and sugar in both. The typical meals

they cooked in Nepal were very similar to what they eat in the U.S. Humaya consumed three meals during the day without any snacks. The main reason for the lack of food between meals was because of the lack of time. His schedule did not allow him to eat throughout the day. He did come home for lunch every day.

Dietary behavior of children: The four children consumed similar foods as Humaya. The only time the children ate differently was when they were at school. The older child, in college, did not come home for lunch. He purchased food for lunch while he was out. Everyone in the household usually ate breakfast and dinner together. They rarely ate food out at restaurants.

9. Ingi from Bangladesh, residing in the U.S. less than 5 years

Personal and Immediate Household and Network: Ingi was 45 years old at the time of the interview. She arrived in the U.S in 2009. Her parents and extended family still live in Bangladesh. She travels back to her country every 5 years. She resided in Bowie and there are about 20 Pakistani families in her community. She described herself as somewhat integrated in the community but she did not own a car so she cannot drive. She met with Asians about 1-2 times a month at the Indian/Pakistani stores.

Food and Shopping Behaviors: Ingi purchased spices and meats from the Asian stores. For breakfast Ingi consumed cereal with whole milk, snacks after breakfast included cake rusk and cheese and crackers. For lunch she usually consumed leftovers and for dinner she cooked Asian foods such as rice and roti with curry, lentils, and vegetables. The usual desserts included cakes and Pakistani Bengali desserts. The meals eaten during the weekdays are the same as weekends except for breakfast. During the weekends she cooked a bigger breakfast including potatoes, curry, eggs, and roti. The foods eaten during the holidays and festivals were the same as other times except that there was a greater variety of foods and desserts during special times. Some of

the normal foods for snacking included salty snacks. In the parental household, she consumed all Bengali foods with a larger emphasis on meat and breakfasts compared to now. She noticed that meat was more expensive in the U.S. compared to her home country.

Dietary behavior of children: Ingi had one son age 19 years old. Her son loved to consume meat like his father. She usually consumes what the mother prepares but he will snack on much more junk food. They did purchase much more "junk food" for the son such as "chips and desserts".

10. Jawaid from Bangladesh, residing in the U.S. less than 5 years

Personal and Immediate Household and Network: Jawaid was 27 on the day of the interview. He had been living in the U.S for 1 year. He moved to the U.S in order to go to college in the U.S. He resided with his uncle and aunt. He lived in a neighborhood that do not have any Asians and he was not integrated into the community. The only time he went to the community center was in Ramadan last year. His parents and the rest of this immediate family were in Bangladesh. He was in school most of the day and did not see Asians in his classes. His contact with Asians was usually his uncle, aunt, and his cousin.

Food and Shopping Behaviors: Jawaid was not responsible for shopping or cooking at home. His uncle and aunt were the ones who shop at Bangla bazar and other Indian spice restaurants. His uncle would sometimes take Jawaid along on shopping trips to help carry heavy bags, etc. Jawaid's typical breakfast meals consisted of cereal, fruit, and sometimes eggs. His lunch was usually purchased from school because he spent long hours at school and his dinner was eaten at home. His aunt cooked dinner at home including foods that he would eat in Bangladesh. The dinner meals contained fish 4 to 5 times a week with cooked mixed vegetable and rice. Sometimes there was chicken, or beef curry. He enjoyed sea food the best and so did his family.

Dietary behavior of children: Jawaid did not have any children.

11. Khalid from Pakistan residing in the U.S. less than 5 years

Personal and Immediate Household and Network: Khalid was 18 years old at the time of the interview 12/1/13 and had lived in Pakistan for 18 years. He just arrived in the U.S. on a green card as a permanent resident. He arrived with his parents and three siblings. He did not have a sizeable proportion of Pakistani and SA's in the neighborhood. Only one family resided nearby. He had not integrated in the community at all and has not reached out to the local religious center. His immediate family members had been his main source of contact and on the weekends the family nearby. Khalid had been utilizing the internet and social media to stay connected to his family and previous friends in Pakistan.

Food and Shopping Behaviors: Khalid did not drive or shop for food in his household. His parents have been responsible for all of the shopping and cooking. Khalid preferred Pakistani food and his regular breakfast, lunch and dinner meals consisted of ethnic foods such as rice, roti, curries, daal (lentils), yogurt, cooked vegetables. Khalid mostly preferred ethnic foods. He did like Chinese food and some other spicy foods from other ethnic groups as well. Khalid had recently experienced culture shock and missed his home country tremendously. Khalid did not have any children.

12.   Leila from Pakistan residing in the U.S. less than 5 years

Personal and Immediate Household and Network: Leila was 49 years old on the day of the interview 11/20/13. She had resided in Pakistan her entire life and had arrived to the U.S. less than one year ago. Her husband and three of her unmarried children had migrated to the U.S. with her but her two sons who are married were still in Pakistan. She will visit her family in Pakistan this year. Leila's community does not have a sizeable proportion of South Asians and

she did not speak English very much. Leila planned on taking English classes at the local community college. She had not integrated within the community and did not plan to become too familiar with them at this time. She had the impression that American culture had something to offer her and she had been trying to learn how to navigate her way in American society.

Food and Shopping Behaviors: Leila had a Pakistani family near her home and they have helped her family with home rental, purchasing a car, and finding local grocery stores that sell ethnic foods. She received her license and had become more independent to purchase her groceries. She purchased ethnic groceries at the Danish Store in Baltimore County about once a month. She purchased meat (halal), spices, and rice, flour, and frozen foods. Her routine week day meal consisted of milk tea in the morning with toast or cake. Lunch was usually rice with lentils or vegetables, and then dinner included curry with either rice or roti and some vegetables. Leila purchased her vegetables, milk, eggs, butter, and bread from local grocery stores such as Giant and Walmart.

Dietary behavior of children: Leila had six children and three of them reside in the U.S. with her while the older three sons were in Pakistan. The ages of her children: her two sons in the U.S. were 16 years old and 10 years old, and daughter 5 years of age. Leila's children consume the food that she cooks. Her 16 year old son had recently acquired employment at a diner and he enjoyed American cuisine. The youngest daughter enjoyed cookies and McDonalds and often gave her mother difficulty about eating healthful foods. The children typical diet consisted of the same foods their mother cooked at home with the exception of lunches which they received from school.

13. Mai from India residing in the U.S. less than 5 years

Personal and Immediate Household and Network: Mai had been in the U.S for 4 years and was of Indian descent but had lived in the Kingdom of Saudi Arabia (KSA) most of her life. Mai was 19 at the time of the interview and was single. Mai's grandparents and many uncles and aunts resided in India. Some of her uncle, aunts, and cousins also lived in KSA. Her family traveled to India three years ago and to KSA last year. Currently, her family resided in a community that had a reasonable Asian community. She attended a community college in proximity to her home and she also had many friends who shared cultural and religious affiliations with her.

Personal and Immediate Household and Network: Her mother did most of the cooking in the home. They consumed two meals at home, usually breakfast and dinner. Lunch was consumed outside of the home most weekdays and weekends were spent out as well. The typical breakfast consisted of cold cereals or toast. Her mother usually cooked whole wheat roti with many cooked vegetables and curries in the evening for dinner on a daily basis. Mai's mother was conscience of cooking with vegetables oils instead of saturated fats. Mai usually consumed snacks between lunch and dinner consisting of fruit such as apples, bananas, and oranges.

Food and Shopping Behaviors: Mai's mother did the grocery shopping for her household from Asian stores about twice a week and other grocery stores such as Giant and Safeway once a week. The typical foods her family purchased from the Asian stores included spices, whole wheat flour, rice and slaughtered meat. She purchased fruits, vegetables, cereals, milk, etc. from Giant and Safeway.

The meals that Mai's household consumed during ordinary days were different from what they consume on holidays. Holiday foods typically contained more sugar and fats.

Dietary behavior of children: Mai did not have any children but she had brother and sisters.

14. Nida from India residing in the U.S. less than 5 years

    Personal and Immediate Household and Network: Nida was 55 at the time of the interview and she had been in the U.S for 2 years. She moved in with her son after her husband passed away in India. She was born in India and she currently resided in Montgomery County. Nida had three children, one son and two daughters. One of her daughters still resided in India and many of her immediate relatives also live in India. Nida also had two grandchildren and they reside in the U.S.

    Nida was not very integrated into her Indian community yet because she did not drive or have employment yet. Nida attended the Hindu temple once a week with her son and that was the only time she integrated with other Asian Indians.

    Food and Shopping Behaviors: Nida's son and daughter in law shopped at Indian and Pakistani grocery stores on a regular basis. Nida's typical breakfast included tea with toast or cookies on weekdays and weekends. Her lunch was usually leftovers from the previous night and at times she would cook during the day time while everyone else in the household was working. She ate what she cooked during lunch and then again for dinner. Her typical meals consisted of rice or whole wheat roti with either lentils and or vegetables. She also cooked curries on the weekdays. On the weekends they consumed the same typical meals, except when her daughter in law cooked. They also enjoyed meals outside of the home on the weekends. The restaurants of choice were Asian including Chinese. She was consuming three regular meals and one snack between breakfast and lunch. Her snack consisted of fresh fruit such as an apple, orange, or banana.

They also shopped at the local American grocery stores such as Shoppers. They usually purchased juice, bread, milk, eggs, and other items that were less expensive at the larger grocery stores. All other groceries were purchased from the Asian stores.

Dietary behavior of children: Nida's three children consumed the same foods as her. Her grandchildren also consumed Indian food expect when they were in school, they ate lunch from school. Nida's eating behaviors were the same in India as they were in the U.S. She was consuming three regular meals. Nida shared more about her grandchildren than her children when we asked her about the children's eating behavior. She told us that her grandchildren really enjoyed her cooking and often asked the grandmother to cook for them. She often enjoyed cooking them a snack when they came home from school such as samosa's (wheat shell stuffed with ground beef and spices and then deep fried) with ketchup. Other times she makes pakoras (chick pea flour with spices also deep fried) in yogurt sauce. She explained that she loved to eat these same foods when she was growing up.

15. Omar from Iran, residing in the U.S. less than 5 years

Personal and Immediate Household and Network: Omar was 52 at the time of the interview. He had lived in the U.S for 4 years. He migrated to the U.S for higher education for his children. He lived in a community that has other Muslims but not Iranians. He attended the community center every Friday for prayer. His immediate family, like his parents and siblings, lived in Iran and most of his friends as well. He had one sister who also lives in the U.S. in Maryland. He visited his sister twice a month. His wife and children also live with him. He and his family have not visited Iran for the past 4 years. Omar did not know when he would go back to Iran.

Food and Shopping Behaviors: Omar and his wife shared shopping responsibilities. They consumed foods very similar to Iran. They consumed a lot of fresh fruit and vegetables that they purchased from farmers markets. They enjoy cooking kabobs and also liked to eat at the Iranian restaurants at times. They consumed foods from other ethnic groups as well like Chinese, Mexican, Italian, etc. They tried their best to be health conscience and eat well.

The foods they purchased from the Arab markets included spices like sumac, zartar, and others. They also purchased their meats from the halal meat stores and especially liked the meat store in Rockville. They rarely shop at supermarkets like Giant and Safeway. The typical breakfast contained hummus and pita or eggs. They also consumed labna (goat yogurt) for breakfast with bread and cheese. For lunch and dinner they consumed rice and meat with fresh vegetables like tomatoes, cucumbers, onions, etc. They did not consume much curry or very hot chili spicy foods.

Dietary behavior of children: Omar's two sons were aged 19 and 16 years old. They were in college and high school respectively. He described his children as easy going and very good children. They consumed similar foods as the parents but on the other hand they did enjoy snacking on junk food more often than the parents. The parents tried to ensure healthy eating habits in their children early on but the peer pressure and television caused their children to try new food ways. In college the older son was very independent and only ate meals at home once in a while. His schedule was also very different than the rest of the family. The 16 year old son played sports so he often needed to consume more snacks compared to parents.

16. Priya from Afghanistan, residing in the U.S. less than 5 years:

Personal and Immediate Household and Network: Priya was 26 at the time of the interview and had been in the U.S. for 3 years. She had all her major family in Afghanistan except her one daughter and her husband. Her parents, brothers, sisters, aunts, uncles and the remainder of her family were in her country. Priya was born in Afghanistan and had lived there her entire life. She has not traveled back to her country from the time she arrived in the U.S. Currently, she had been living in a community with some Asian families. She had recently met another Afghani family from coming to the clinic for medical treatment. Priya was not very active in her community but would like to make more friends because she often gets lonely.

Food and Shopping Behaviors: Priya usually shopped with her husband and daughter because she did not drive and does not work. Her husband takes her to the Asian grocery store called Indus and Kashmir Bazar for Islamically slaughtered meat, spices for curries, lentils, rice, whole wheat flour, and other specialty items such as cake rusks, and detol. She bought most of her groceries from these stores about once a week. Her diet was monotonous because she ate cake rusks with tea every morning for breakfast. She would cook one time during the day before her daughter and husband came home for dinner and she would eat that food for lunch and dinner. She prepared rice and curry with lentils or frozen vegetables. She did not usually eat snacks during the day. The only thing she may drink is tea during the afternoon. She would alternate rice with homemade roti every other day. The family usually did not go out to eat. They very rarely shopped any place other than Asian grocery markets. Her husband would usually buy milk and cookies from 7/11 for the family.

Dietary behavior of children: Priya's daughter was 6 years old at the time of the interview. She was in first grade attending public school. They moved out of Afghanistan for a better

future for their daughter. Their daughter was consuming the same foods as the parents for breakfast and dinner. Breakfast was usually just toast with jelly and lunch was consumed at school. Their daughter often asked for McDonald's but they would not stop to purchase it.

Conclusion

The food pathways of the South Asian American Community were similar in some respects yet different for other individuals who lived in the U.S. for more than 5 years and less than 5 years. Some similarities emerged for those who lived in the U.S. for more than 5 years. They shopped at both Asian stores as well as the large American grocery markets. They often utilized the Asian grocery stores for spices and meats and the remainder of their groceries were purchased from other stores. The South Asian in the U.S for a longer time also had a mixed diet. They consumed cereals for breakfast and sandwiches for lunch. The ethnic foods were the main cuisine during dinner time. The individuals that were in the U.S. longer also were integrated into the Asian community more than those who were resident in the U.S. for less than years. It may be that they had more transportation compared to the less acculturated. The children of these more acculturated Asians were eating differently from their parents during the school hours and also at home. The parents would purchase more food items from the American grocery stores for snacks.

The South Asians that were in the U.S. for less than 5 years were eating the same foods for lunch and dinner and often times cooked only once in the day and ate all their leftovers. They were less likely to eat out at fast food restaurants. The children of these Asians were becoming more acculturated with exposure to Americans through school and at times with T.V. The less

acculturated Asians also seemed to be more isolated from the Asian community and reside in communities with less Asians.

A number of very important questions arose from the case studies that would be important to investigate further: 1)What do the terms "healthy" and "non-healthy" mean to South Asians? 2) What are some examples of "healthy" and "non-healthy" foods in the Asian culture and what are some examples of "healthy" and "non-healthy" American foods? 3) Do South Asians feel that the "outside environment" have a good or bad impact on the health of children vis-à-vis food? 4) Do South Asians consider indigenous foods healthy?

Macronutrient Consumption Among South Asians Americans in 2 Community Health Center in Maryland by Gender

	Males (n=181)	Females(202)	
	Mean±SD	Mean±SD	P-value
Total Calories	2042±571	1731±579	<0.001*
Protein	103±64	80±34	<0.0002*
Carbohydrates	249±100	226±87	0.0151*
Total Fat	68±32	57±28	0.007*
Saturated Fat	18±12	16±9	0.1894
Cholesterol#	257±204	214±173	0.0271*
Sodium@	3815±1815	3708±1638	0.5483

*These values were statistically significant between males and females
@The RDA for sodium is ≤2,400 mg/day, according to the USDA for.
The RDI for cholesterol is ≤300 mg/day, according to DRI.

SUINN-LEW ASIAN SELF-IDENTITY ACCULTURATION SCALSE (SL-ASIA)

INSTRUCTIONS: The questions which follow are for the purpose of collecting information about your historical background as well as more recent behaviors which may be related to your cultural identity. Choose the one answer which best describes you.

1. What language can you speak?
    1. Asian only (for example, Indian, Pakistani, Bengali, Nepali, Sri Lankan, etc.)
    2. Mostly Asian, some English
    3. Asian and English about equally well (bilingual)
    4. Mostly English, some Asian
    5. Only English

2. What language do you prefer?
    1. Asian only (for example, Indian, Pakistani, Bengali, Nepali, Sri Lankan, etc.)
    2. Mostly Asian, some English
    3. Asian and English about equally well (bilingual)
    4. Mostly English, some Asian
    5. Only English

3. How do you identify yourself?
    1. Indian, Pakistani, Bengali, Nepali, Sri Lankan, etc
    2. Asian
    3. Asian-American
    4. Indian-American, Pakistani-American, Bengali-American, Sri-Lankan-American, etc.)
    5. American

4. Which identification does (did) your mother use?
    1. Indian, Pakistani, Bengali, Nepali, Sri Lankan, etc
    2. Asian
    3. Asian-American
    4. Indian-American, Pakistani-American, Bengali-American, Sri-Lankan-American, etc.)
    5. American

5. Which identification does (did) your father use?
    1. Indian, Pakistani, Bengali, Nepali, Sri Lankan, etc
    2. Asian
    3. Asian-American

4. Indian-American, Pakistani-American, Bengali-American, Sri-Lankan-American, etc.)
5. American

6. What was the ethnic origin of the friends and peers you had, as a child up to age 6?
   1. Almost exclusively Asians, Asian-Americans, Orientals
   2. Mostly Asians, Asian-Americans, Orientals
   3. About equally Asian groups and Anglo groups
   4. Mostly Anglos, Blacks, Hispanics, or other non-Asian ethnic groups
   5. Almost exclusively Anglos, Blacks, Hispanics, or other non-Asian ethnic groups

7. What was the ethnic origin of the friends and peers you had, as a child from 6 to 18?
   1. Almost exclusively Asians, Asian-Americans, Orientals
   2. Mostly Asians, Asian-Americans, Orientals
   3. About equally Asian groups and Anglo groups
   4. Mostly Anglos, Blacks, Hispanics, or other non-Asian ethnic groups
   5. Almost exclusively Anglos, Blacks, Hispanics, or other non-Asian ethnic groups

8. Whom do you now associate with in the community?
   1. Almost exclusively Asians, Asian-Americans, Orientals
   2. Mostly Asians, Asian-Americans, Orientals
   3. About equally Asian groups and Anglo groups
   4. Mostly Anglos, Blacks, Hispanics, or other non-Asian ethnic groups
   5. Almost exclusively Anglos, Blacks, Hispanics, or other non-Asian ethnic groups

9. If you could pick, whom would you prefer to associate with in the community?
   1. Almost exclusively Asians, Asian-Americans, Orientals
   2. Mostly Asians, Asian-Americans, Orientals
   3. About equally Asian groups and Anglo groups
   4. Mostly Anglos, Blacks, Hispanics, or other non-Asian ethnic groups
   5. Almost exclusively Anglos, Blacks, Hispanics, or other non-Asian ethnic groups

10. What is your music preference?
    1. Only Asian music (for example, Indian, Pakistani, Bengali, Nepali, Sri Lankan, etc.
    2. Mostly Asian
    3. Equally Asian and English
    4. Mostly English
    5. English only

11. What is your movie preference?
    1. Asian-language movies only
    2. Asian-language movies mostly
    3. Equally Asian/English English-language movies
    4. Mostly English-language movies only
    5. English-language movies only

12. What generation are you?
    1. 1st Generation = I was born in Asian or country other than U.S.
    2. 2nd Generation = I was born in U.S., either parent was born in Asian or country other than U.S.
    3. 3rd Generation = I was born in U.S., both parents were born in U.S., and all grandparents born in Asian or country other than U.S.
    4. 4th Generation = I was born in U.S., both parents were born in the U.S, and at least one grandparent born in Asia or country other than U.S. and one grandparent born in U.S.
    5. 5th Generation = I was born in the U.S., both parents were born in the U.S., and all grandparents also born in the U.S.
    6. Don't know what generation best fits since I lack some information

13. Where were you raised?
    1. In Asia only
    2. Mostly in Asia, some in U.S.
    3. Equally in Asia and U.S.
    4. Mostly in U.S., some in Asia
    5. In U.S. only

14. What contact have you had with Asia?
    1. Raised one year or more in Asia
    2. Lived for less than one year in Asia
    3. Occasional visits to Asia
    4. Occasional communications (letters, phone calls, etc.) with people in Asia
    5. No exposure or communication with people in Asia

15. What is your food preference at home?
    1. Exclusively Asian food
    2. Mostly Asian food, some American
    3. About equally Asian and American
    4. Mostly American food
    5. Exclusively American food

16. What is your food preference in restaurants?
    1. Exclusively Asian food
    2. Mostly Asian food, some American
    3. About equally Asian and American
    4. Mostly American food
    5. Exclusively American food

17. Do you
    1. Read only an Asian language?
    2. Read an Asian language better than English?
    3. Read both Asian and English equally well?
    4. Read English better than an Asian language?
    5. Read only English?

18. Do you
    1. Write only an Asian language?
    2. Write an Asian language better than English?
    3. Write both Asian and English equally well?
    4. Write English better than an Asian language?
    5. Write only English?

19. If you consider yourself a member of the Asian group (Oriental, Asian, Asian-American, Indian-American, Pakistani-American), how much pride do you have in this group?
    1. Extremely proud
    2. Moderately proud
    3. Little pride
    4. No pride but **do not** feel negative toward group
    5. No pride but **do** feel negative toward group

20. How would you rate yourself?
    1. Very Asian
    2. Mostly Asian
    3. Bicultural
    4. Mostly Westernized
    5. Very Westernized

21. Do you participate in Asian occasions, holidays, traditions, etc?
    1. Nearly all
    2. Mostly of them

3. Some of them
4. A few of them
5. None at all

22. Rate yourself on how much you believe in Asian values (e.g. about marriage, families, education, work):

          1   2   3   4   5

(Do not believe)   (Strongly believe in Asian values)

23. Rate yourself on how much you believe in American (Western) values:

     1   2   3   4   5

(Do not believe)   (Strongly believe in Asian values)

24. Rate yourself on how well you fit in with other Asians of the same ethnicity:

     1   2   3   4   5

(Do not fit)   (Fit very well)

25. Rate yourself on how well you fit in with other Americans who are non-Asian (Westerners):

     1   2   3   4   5

(Do not fit)   (Fit very well)

26. There are many different ways in which people think of themselves. Which ONE of the following most closely describes how you view yourself?
    1. I consider myself basically an Asian person (e.g., Indian, Pakistani, Bengali, Nepali, Sri Lankan, Iranian, etc.). Even though I live and work in American, I still view myself basically as an Asian person.
    2. I consider myself basically as an American. Even though I have an Asian background and characteristics, I still view myself basically as an Americans.

3. I consider myself as an Asian-American, although deep down I always know I am an Asian.
4. I consider myself as an Asian-American, although deep down, I view myself as an American first.
5. I consider myself as an Asian-American. I have both Asian and American characteristics, and I view myself as a blend of both.

Questionnaire for Case Studies

A. Personal and Immediate Household and Network Food Behaviors?

1) Where did you grow up?

2) When did migrate to the US?

3) Do you have relatives who live in the country in which they grew up;

4) How often do you go back to the country in which you grew up.

5) In the US, do you live in a community that has a sizeable proportion of people of your ethnic background, or very few of such people beside yourself.

6) beyond your neighborhood, how integrated would you say you are with other people of your ethnicity in the US?

7) How often do you see these people, and under what circumstances

8) When shopping, how often would you say that you purchase foods preferred by members of your ethnic group?

9) What are some of the ethnic foods do you purchase more frequently.

10) What is included a routine week-day meal in your household?

11) What about during the weekend, do you and your family tend to eat differently than during the week? And if so, how is that?

12) What about holidays, special feasts, and other festive occasions, are there foods that you eat that are different than what you eat during regular days? If so, what are such foods?

13) How often do you snack between meals?

14) What are some of the foods that you normally snack on?

B. Parental Household

1) what would be included in routine week day meals in the household in which you grew up?

What do you think accounts for the change in your dietary behavior, from those in the household(s) in which you grew up?

C. The Dietary Behavior of Your Children

1) How many children do you have? What are their ages? (Children should be given pseudonyms).

2) Would you say that their food behaviors are similar to your own? Weekdays, Weekends, Snacking, Holidays and Festive Occasions, etc? (Explore this with each child).

3) For each of your children, who seem to have food behaviors different than your own, what do you think accounts for these differences.

References

1. Misra A, Khurana L, Isharwal S, Bhardwaj S. South Asian diets and insulin resistance. British Journal of Nutrition 2009;101(4):465-73. doi: 10.1017/s0007114508073649.
2. Brawley OW, Freeman HP. Race and outcomes: is this the end of the beginning for minority health research? Journal Of The National Cancer Institute 1999;91(22):1908-9.
3. Flowers E, Molina C, Mathur A, et al. Prevalence of metabolic syndrome in South Asians residing in the United States. Metabolic Syndrome And Related Disorders 2010;8(5):417-23.
4. Hu FB, Meigs JB, Li TY, Rifai N, Manson JE. Inflammatory markers and risk of developing type 2 diabetes in women. Diabetes 2004;53(3):693-700.
5. King TE, Jr., Brunetta P. Racial disparity in rates of surgery for lung cancer. The New England Journal Of Medicine 1999;341(16):1231-3.
6. Cameron AJ, Shaw JE, Zimmet PZ. The metabolic syndrome: prevalence in worldwide populations. Endocrinology and Metabolism Clinics of North America 2004;33(2):351-+. doi: 10.1016/j.ecl.2004.03.005.
7. Gu D, Reynolds K, Wu X, et al. Prevalence of the metabolic syndrome and overweight among adults in China. The Lancet;365(9468):1398-405. doi: 10.1016/s0140-6736(05)66375-1.
8. AM M. Death in the United States, 2009. Hyattsville, MD: National Center for Health Statistics, 2011.
9. Alberti KGMM, Eckel RH, Grundy SM, et al. Harmonizing the Metabolic Syndrome: A Joint Interim Statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. Circulation 2009;120(16):1640-5.
10. Alberti KGMM, Zimmet P, Shaw J. Metabolic syndrome—a new world-wide definition. A Consensus Statement from the International Diabetes Federation. Diabetic Medicine 2006;23(5):469-80.
11. Beltrán-Sánchez H, Harhay MO, Harhay MM, McElligott S. Prevalence and Trends of Metabolic Syndrome in the Adult U.S. Population, 1999–2010. Journal of the American College of Cardiology 2013;62(8):697-703. doi: 10.1016/j.jacc.2013.05.064.
12. Chowdhury TA, Lasker SS. Complications and cardiovascular risk factors in South Asians and Europeans with early-onset type 2 diabetes. QJM 2002;95(4):241-6.
13. Gupta M, Singh N, Verma S. South Asians and Cardiovascular Risk: What Clinicians Should Know. Circulation 2006;113(25):e924-e9.
14. Patterson GJ. A Critique of "The New Ethnicity". American Anthropologist 1979;81(1):103-5. doi: 10.2307/677220.
15. Mokdad AH, Marks JS, Stroup DF, Gerberding JL. ACtual causes of death in the united states, 2000. JAMA 2004;291(10):1238-45. doi: 10.1001/jama.291.10.1238.
16. Health USDo. Healthy people 2010: Government Printing Office, 2000.
17. McKeigue PM, Miller GJ, Marmot MG. Coronary heart disease in south Asians overseas: a review. Journal of clinical epidemiology 1989;42(7):597-609.
18. Sevak L, McKeigue PM, Marmot MG. Relationship of hyperinsulinemia to dietary intake in south Asian and European men. The American Journal of Clinical Nutrition 1994;59(5):1069-74.

19. Garduño-Diaz SD, Khokhar S. Prevalence, risk factors and complications associated with type 2 diabetes in migrant South Asians. Diabetes/Metabolism Research and Reviews 2012;28(1):6-24. doi: 10.1002/dmrr.1219.
20. NHANES 2011-2012 Overview.
21. Cooper H. Investigating socio-economic explanations for gender and ethnic inequalities in health. Social Science & Medicine (1982) 2002;54(5):693-706.
22. Nazroo JY. Genetic, cultural or socio-economic vulnerability? Explaining ethnic inequalities in health. Sociology of Health & Illness 1998;20(5):710-30. doi: 10.1111/1467-9566.00126.
23. Association AD.
24. Alberti KG, Zimmet PZ. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus provisional report of a WHO consultation. Diabetic Medicine: A Journal Of The British Diabetic Association 1998;15(7):539-53.
25. Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) Final Report. Circulation 2002;106(25):3143-.
26. Grundy SM, Cleeman JI, Daniels SR, et al. Diagnosis and management of the metabolic syndrome. An American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement. Executive summary. Cardiology In Review 2005;13(6):322-7.
27. Balkau B, Charles M-A, Drivsholm T, et al. Frequency of the WHO metabolic syndrome in European cohorts, and an alternative definition of an insulin resistance syndrome. Diabetes & Metabolism 2002;28(5):364-76.
28. Tan C-E, Ma S, Wai D, Chew S-K, Tai ES. Can we apply the National Cholesterol Education Program Adult Treatment Panel definition of the metabolic syndrome to Asians? Diabetes Care 2004;27(5):1182-6.
29. Lear SA, Toma M, Birmingham CL, Frohlich JJ. Modification of the relationship between simple anthropometric indices and risk factors by ethnic background. Metabolism: Clinical And Experimental 2003;52(10):1295-301.
30. Alberti KGMM, Eckel RH, Grundy SM, et al. Harmonizing the Metabolic Syndrome. Circulation 2009;120(16):1640-5.
31. Diagnosis and Classification of Diabetes Mellitus. Diabetes Care 2006;29(suppl 1):s43-s8.
32. DeFronzo RA, Ferrannini E. Insulin resistance. A multifaceted syndrome responsible for NIDDM, obesity, hypertension, dyslipidemia, and atherosclerotic cardiovascular disease. Diabetes Care 1991;14(3):173-94.
33. Matthews D, Hosker J, Rudenski A, Naylor B, Treacher D, Turner R. Homeostasis model assessment: insulin resistance and β-cell function from fasting plasma glucose and insulin concentrations in man. Diabetologia 1985;28(7):412-9. doi: 10.1007/bf00280883.
34. Misra A, Khurana L. Obesity and the metabolic syndrome in developing countries. J Clin Endocrinol Metab 2008;93(11 Suppl 1):S9-30. doi: 10.1210/jc.2008-1595.
35. Li G, Chen X, Jang Y, et al. Obesity, coronary heart disease risk factors and diabetes in Chinese: an approach to the criteria of obesity in the Chinese population. Obesity Reviews: An Official Journal Of The International Association For The Study Of Obesity 2002;3(3):167-72.

36.   Zhou BF. Effect of body mass index on all-cause mortality and incidence of cardiovascular diseases - Report for meta-analysis of prospective studies on optimal cut-off points of body mass index in Chinese adults. Biomedical and Environmental Sciences 2002;15(3):245-52.

37.   Snehalatha C, Viswanathan V, Ramachandran A. Cutoff values for normal anthropometric variables in asian Indian adults. Diabetes Care 2003;26(5):1380-4.

38.   Zhu S, Wang Z, Heshka S, Heo M, Faith MS, Heymsfield SB. Waist circumference and obesity-associated risk factors among whites in the third National Health and Nutrition Examination Survey: clinical action thresholds. The American Journal Of Clinical Nutrition 2002;76(4):743-9.

39.   Zhu S, Heshka S, Wang Z, et al. Combination of BMI and Waist Circumference for Identifying Cardiovascular Risk Factors in Whites. Obesity Research 2004;12(4):633-45.

40.   Janssen I, Katzmarzyk PT, Ross R. Waist circumference and not body mass index explains obesity-related health risk. The American Journal Of Clinical Nutrition 2004;79(3):379-84.

41.   Banerji MA, Faridi N, Atluri R, Chaiken RL, Lebovitz HE. Body composition, visceral fat, leptin, and insulin resistance in Asian Indian men. J Clin Endocrinol Metab 1999;84(1):137-44. doi: 10.1210/jcem.84.1.5371.

42.   Chowdhury B, Lantz H, Sjostrom L. Computed tomography-determined body composition in relation to cardiovascular risk factors in Indian and matched Swedish males. Metabolism 1996;45(5):634-44.

43.   Carr A EB. Blood Pressure in Small Animals-Hypertension-Target organ damage, Heart and Kidney. Cardiology 2009;1(19):1-5.

44.   Carr MC, Brunzell JD. Abdominal obesity and dyslipidemia in the metabolic syndrome: importance of type 2 diabetes and familial combined hyperlipidemia in coronary artery disease risk. The Journal Of Clinical Endocrinology And Metabolism 2004;89(6):2601-7.

45.   Kaplan NM. The deadly quartet. Upper-body obesity, glucose intolerance, hypertriglyceridemia, and hypertension. Archives Of Internal Medicine 1989;149(7):1514-20.

46.   Isomaa B, Almgren P, Tuomi T, et al. Cardiovascular morbidity and mortality associated with the metabolic syndrome. Diabetes Care 2001;24(4):683-9.

47.   Mackenzie IS, McEniery CM, Dhakam Z, Brown MJ, Cockcroft JR, Wilkinson IB. Comparison of the effects of antihypertensive agents on central blood pressure and arterial stiffness in isolated systolic hypertension. Hypertension 2009;54(2):409-13.

48.   Rizzo M, Kotur-Stevuljevic J, Berneis K, et al. Atherogenic dyslipidemia and oxidative stress: a new look. Translational Research: The Journal Of Laboratory And Clinical Medicine 2009;153(5):217-23.

49.   Ayyobi AF, Brunzell JD. Lipoprotein distribution in the metabolic syndrome, type 2 diabetes mellitus, and familial combined hyperlipidemia. The American Journal Of Cardiology 2003;92(4A):27J-33J.

50.   Rosenson RS. New approaches in the intensive management of cardiovascular risk in the metabolic syndrome. Current Problems In Cardiology 2005;30(5):241-79.

51.   Ghanim H, Aljada A, Hofmeyer D, Syed T, Mohanty P, Dandona P. Circulating mononuclear cells in the obese are in a proinflammatory state. Circulation 2004;110(12):1564-71.

52. Pearson TA, Mensah GA, Alexander RW, et al. Markers of inflammation and cardiovascular disease: application to clinical and public health practice: A statement for healthcare professionals from the Centers for Disease Control and Prevention and the American Heart Association. Circulation 2003;107(3):499-511.

53. Guven A, Cetinkaya A, Aral M, et al. High-Sensitivity C-Reactive Protein in Patients with Metabolic Syndrome. Angiology 2006;57(3):295-302.

54. Flock MR, Green MH, Kris-Etherton PM. Effects of adiposity on plasma lipid response to reductions in dietary saturated Fatty acids and cholesterol. Advances In Nutrition (Bethesda, Md) 2011;2(3):261-74.

55. Durina J, Remkova A. Prothrombotic state in metabolic syndrome. Bratislavské Lekárske Listy 2007;108(6):279-80.

56. Sarti C, Gallagher J. The metabolic syndrome: prevalence, CHD risk, and treatment. Journal Of Diabetes And Its Complications 2006;20(2):121-32.

57. Meigs JB, Mittleman MA, Nathan DM, et al. Hyperinsulinemia, hyperglycemia, and impaired hemostasis: the Framingham Offspring Study. JAMA: The Journal Of The American Medical Association 2000;283(2):221-8.

58. Fonseca V, Guba SC, Fink LM. Hyperhomocysteinemia and the endocrine system: implications for atherosclerosis and thrombosis. Endocrine Reviews 1999;20(5):738-59.

59. Calles-Escandon J, Cipolla M. Diabetes and endothelial dysfunction: a clinical perspective. Endocrine Reviews 2001;22(1):36-52.

60. Steinberg HO, Chaker H, Leaming R, Johnson A, Brechtel G, Baron AD. Obesity/insulin resistance is associated with endothelial dysfunction. Implications for the syndrome of insulin resistance. The Journal Of Clinical Investigation 1996;97(11):2601-10.

61. Dunaif A, Graf M, Mandeli J, Laumas V, Dobrjansky A. Characterization of groups of hyperandrogenic women with acanthosis nigricans, impaired glucose tolerance, and/or hyperinsulinemia. The Journal Of Clinical Endocrinology And Metabolism 1987;65(3):499-507.

62. Dunaif A. Insulin resistance and the polycystic ovary syndrome: mechanism and implications for pathogenesis. Endocrine Reviews 1997;18(6):774-800.

63. Marchesini G, Brizi M, Bianchi G, et al. Nonalcoholic fatty liver disease: a feature of the metabolic syndrome. Diabetes 2001;50(8):1844-50.

64. Lebovitz HE. Oral therapies for diabetic hyperglycemia. Endocrinology And Metabolism Clinics Of North America 2001;30(4):909-33.

65. Meigs JB, D'Agostino RB, Sr., Wilson PW, Cupples LA, Nathan DM, Singer DE. Risk variable clustering in the insulin resistance syndrome. The Framingham Offspring Study. Diabetes 1997;46(10):1594-600.

66. Matthaei S, Stumvoll M, Kellerer M, Häring HU. Pathophysiology and pharmacological treatment of insulin resistance. Endocrine Reviews 2000;21(6):585-618.

67. RA D. Glucose tolerance and aging. Diabetes 1997(28):1099-101.

68. Williams G PJ. Handbook of Diabetes. 2nd ed. Oxford: Blackwell Science, 1999.

69. Kissebah AH, Freedman DS, Peiris AN. Health risks of obesity. The Medical Clinics Of North America 1989;73(1):111-38.

70. Boden G. Role of fatty acids in the pathogenesis of insulin resistance and NIDDM. Diabetes 1997;46(1):3-10.

71. Moller DE. Potential role of TNF-alpha in the pathogenesis of insulin resistance and type 2 diabetes. Trends In Endocrinology And Metabolism: TEM 2000;11(6):212-7.

72. Peraldi P, Spiegelman B. TNF-alpha and insulin resistance: summary and future prospects. Molecular And Cellular Biochemistry 1998;182(1-2):169-75.
73. Steppan CM, Bailey ST, Bhat S, et al. The hormone resistin links obesity to diabetes. Nature 2001;409(6818):307-12.
74. Colwell JA. Treatment for the procoagulant state in type 2 diabetes. Endocrinology And Metabolism Clinics Of North America 2001;30(4):1011-30.
75. Almind K, Bjorbaek C, Vestergaard H, Hansen T, Echwald S, Pedersen O. AMINO-ACID POLYMORPHISMS OF INSULIN-RECEPTOR SUBSTRATE-1 IN NON-INSULIN-DEPENDENT DIABETES-MELLITUS. Lancet 1993;342(8875):828-32. doi: 10.1016/0140-6736(93)92694-o.
76. Hansen T, Andersen CB, Echwald SM, et al. Identification of a common amino acid polymorphism in the p85 alpha regulatory subunit of phosphatidylinositol 3-kinase - Effects on glucose disappearance constant, glucose effectiveness, and the insulin sensitivity index. Diabetes 1997;46(3):494-501. doi: 10.2337/diabetes.46.3.494.
77. Chen H, Charlat O, Tartaglia LA, et al. Evidence that the diabetes gene encodes the leptin receptor: identification of a mutation in the leptin receptor gene in db/db mice. Cell 1996;84(3):491-5.
78. The IDF consensus worldwide definition of the metabolic syndrome. International Diabetes Federation, 2005.
79. Ford ES, Giles WH, Dietz WH. Prevalence of the metabolic syndrome among US adults - Findings from the Third National Health and Nutrition Examination Survey. Jama-Journal of the American Medical Association 2002;287(3):356-9. doi: 10.1001/jama.287.3.356.
80. Ford ES. Prevalence of the metabolic syndrome defined by the International Diabetes Federation among adults in the U.S. Diabetes Care 2005;28(11):2745-9. doi: 10.2337/diacare.28.11.2745.
81. Heart Disease and Stroke Statistics — 2007 Update. Dallas, Texas: American Heart Association, 2007.
82. Park Y-W, Zhu S, Palaniappan L, Heshka S, Carnethon MR, Heymsfield SB. The metabolic syndrome: prevalence and associated risk factor findings in the US population from the Third National Health and Nutrition Examination Survey, 1988-1994. Archives Of Internal Medicine 2003;163(4):427-36.
83. Ervin RB. Prevalence of metabolic syndrome among adults 20 years of age and over, by sex, age, race and ethnicity, and body mass index: United States, 2003-2006. National Health Statistics Reports 2009(13):1-7.
84. Nations U. 2010.
85. Bhopal R, Donaldson L. White, European, western, Caucasian, or what? Inappropriate labeling in research on race, ethnicity, and health. American Journal of Public Health 1998;88(9):1303-7. doi: 10.2105/ajph.88.9.1303.
86. D M. Race and ethnicity in modern Britain. Oxford: Oxford University Press, 2000.
87. Wilcox S, Shumaker SA, Bowen DJ, et al. Promoting adherence and retention to clinical trials in special populations: a women's health initiative workshop. Controlled Clinical Trials 2001;22(3):279-89.
88. Jain C, Narayan N, Narayan K, et al. Attitudes of Asian patients in Birmingham to general practitioner services. The Journal Of The Royal College Of General Practitioners 1985;35(278):416-8.

89.   Davis S AM. Eastern treatment for Eastern health. Journal of Comunity Nursing 1979(May 16).
90.   Race, Ethnicity & Health Care. The Kaiser Family Foundation, 2008.
91.   Misra A, Khurana L. The metabolic syndrome in South Asians: epidemiology, determinants, and prevention. Metabolic Syndrome And Related Disorders 2009;7(6):497-514.
92.   Misra A, Misra R, Wijesuriya M, Banerjee D. The metabolic syndrome in South Asians: continuing escalation & possible solutions. The Indian Journal Of Medical Research 2007;125(3):345-54.
93.   Misra A, Khurana L. Obesity and the metabolic syndrome in developing countries. The Journal Of Clinical Endocrinology And Metabolism 2008;93(11 Suppl 1):S9-S30.
94.   Mohan V, Shanthirani S, Deepa R, Premalatha G, Sastry NG, Saroja R. Intra-urban differences in the prevalence of the metabolic syndrome in southern India -- the Chennai Urban Population Study (CUPS No. 4). Diabetic Medicine: A Journal Of The British Diabetic Association 2001;18(4):280-7.
95.   Bild DE, Bluemke DA, Burke GL, et al. Multi-Ethnic Study of Atherosclerosis: Objectives and Design. American Journal of Epidemiology 2002;156(9):871-81.
96.   . Internet: https://www.cia.gov/library/publications/the-world-factbook/geos/us.html (accessed January 2011.
97.   . Internet: http://www.census.gov/ (accessed January 2011).
98.   Amereidia.
99.   Corbie-Smith G, Flagg EW, Doyle JP, O'Brien MA. Influence of usual source of care on differences by race/ethnicity in receipt of preventive services. Journal Of General Internal Medicine 2002;17(6):458-64.
100.   Schott J, Henley A. Culture, religion and patient care. Nursing Management (Harrow, London, England: 1994) 2000;7(1):13-6.
101.   Modood T BR. Ethnic minorities in Britain, diversity and disadvantage. London: Policy Study Institute, 1997.
102.   Chattoo S A. The meaning of cancer: illness, biography and social identity. London: Routlege, 2003.
103.   K R. Black and ethnic minority groups in England: health and lifestyles. London: Health Education Authority, 1994.
104.   Oppedal B, Røysamb E, Heyerdahl S. Ethnic group, acculturation, and psychiatric problems in young immigrants. Journal Of Child Psychology And Psychiatry, And Allied Disciplines 2005;46(6):646-60.
105.   Misra A, Ganda OP. Migration and its impact on adiposity and type 2 diabetes. Nutrition (Burbank, Los Angeles County, Calif) 2007;23(9):696-708.
106.   Chakraborty BM, Chakraborty R. Concept, measurement and use of acculturation in health and disease risk studies. Collegium Antropologicum 2010;34(4):1179-91.
107.   Abraído-Lanza AF, Dohrenwend BP, Ng-Mak DS, Turner JB. The Latino mortality paradox: a test of the "salmon bias" and healthy migrant hypotheses. American Journal of Public Health 1999;89(10):1543-8. doi: 10.2105/AJPH.89.10.1543.
108.   Franzini L, Ribble JC, Keddie AM. Understanding the Hispanic paradox. Ethnicity & disease 2001;11(3):496-518.

109.	Suinn RM, Rickardfigueroa K, Lew S, Vigil P. THE SUINN-LEW ASIAN SELF-IDENTITY ACCULTURATION SCALE - AN INITIAL REPORT. Educational and Psychological Measurement 1987;47(2):401-7. doi: 10.1177/0013164487472012.
110.	Cuellar I, Arnold B, Maldonado R. ACCULTURATION RATING-SCALE FOR MEXICAN-AMERICANS II - A REVISION OF THE ORIGINAL ARSMA SCALE. Hispanic Journal of Behavioral Sciences 1995;17(3):275-304. doi: 10.1177/07399863950173001.
111.	Dodani S, Dong L. IMPACT OF ACCULTURATION ON CORONARY ARTERY DISEASE IN THE SOUTH ASIAN IMMIGRANTS-UNIQUE POPULATION WITH INCREASED RISK. Journal of Epidemiology and Community Health 2011;65:A237-A. doi: 10.1136/jech.2011.142976h.100.
112.	Must A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH. The Disease Burden Associated With Overweight and Obesity. JAMA: The Journal of the American Medical Association 1999;282(16):1523-9.
113.	Krauss RM, Eckel RH, Howard B, et al. AHA Dietary Guidelines: revision 2000: A statement for healthcare professionals from the Nutrition Committee of the American Heart Association. Stroke; A Journal Of Cerebral Circulation 2000;31(11):2751-66.
114.	American Diabetes Association position statement: evidence-based nutrition principles and recommendations for the treatment and prevention of diabetes and related complications. Journal Of The American Dietetic Association 2002;102(1):109-18.
115.	Thompson FE, Midthune D, Subar AF, Kahle LL, Schatzkin A, Kipnis V. Performance of a short tool to assess dietary intakes of fruits and vegetables, percentage energy from fat and fibre. Public Health Nutrition 2004;7(8):1097-105.
116.	Blanton CA, Moshfegh AJ, Baer DJ, Kretsch MJ. The USDA Automated Multiple-Pass Method Accurately Estimates Group Total Energy and Nutrient Intake. The Journal of Nutrition 2006;136(10):2594-9.
117.	Kennedy ET, Ohls J, Carlson S, Fleming K. The Healthy Eating Index: Design and Applications. Journal of the American Dietetic Association 1995;95(10):1103-8.
118.	Guenther PM, Casavale KO, Reedy J, et al. Update of the Healthy Eating Index: HEI-2010. Journal of the Academy of Nutrition and Dietetics 2013;113(4):569-80. doi: http://dx.doi.org/10.1016/j.jand.2012.12.016.
119.	Comparing the HEI-2005 & HEI-2010. National Cancer Institute.
120.	Guenther PM, Kirkpatrick SI, Reedy J, et al. The Healthy Eating Index-2010 Is a Valid and Reliable Measure of Diet Quality According to the 2010 Dietary Guidelines for Americans. The Journal of Nutrition 2014.
121.	Misra R, Patel T, Kotha P, et al. Prevalence of diabetes, metabolic syndrome, and cardiovascular risk factors in US Asian Indians: results from a national study. Journal Of Diabetes And Its Complications 2010;24(3):145-53.
122.	. Internet: http://mccmdclinic.org/ (accessed March 13, June 15 2011).
123.	*Ellen Anderson and Lois Steinfeldt*. Blaise Instrument Design for Automated Food Coding. Internet: http://www.ars.usda.gov/SP2UserFiles/Place/12355000/pdf/other/Blaise_Instrument_Design.pdf accessed Date Accessed)|.
124.	Cabassa LJ. Measuring acculturation: Where we are and where we need to go. Hispanic Journal of Behavioral Sciences 2003;25(2):127-46. doi: 10.1177/0739986303025002001.

125. Cruz TH, Marshall SW, Bowling JM, Villaveces A. The validity of a proxy acculturation scale among U.S. Hispanics. Hispanic Journal of Behavioral Sciences 2008;30(4):425-46. doi: 10.1177/0739986308323653.
126. http://www.questdiagnostics.com/home.html.
127. Insitute NC. HEI Tools for Researchers. Applied Research and Sciences.
128. Ram CVS, Farmer JA. Metabolic syndrome in South Asians. Journal Of Clinical Hypertension (Greenwich, Conn) 2012;14(8):561-5. doi: 10.1111/j.1751-7176.2012.00652.x.
129. Jordan HT, Tabaei BP, Nash D, Angell SY, Chamany S, Kerker B. Metabolic syndrome among adults in New York City, 2004 New York City Health and Nutrition Examination Survey. Preventing Chronic Disease 2012;9:E04-E.
130. Gupta R, Deedwania PC, Gupta A, Rastogi S, Panwar RB, Kothari K. Prevalence of metabolic syndrome in an Indian urban population. Int J Cardiol 2004;97(2):257-61. doi: 10.1016/j.ijcard.2003.11.003.
131. Dudeja V, Misra A, Pandey RM, Devina G, Kumar G, Vikram NK. BMI does not accurately predict overweight in Asian Indians in northern India. The British Journal Of Nutrition 2001;86(1):105-12.
132. Dodani S, Henkhaus R, Wick J, et al. Metabolic syndrome in South Asian immigrants: more than low HDL requiring aggressive management. Lipids In Health And Disease 2011;10:45-. doi: 10.1186/1476-511X-10-45.
133. Khanna R, Kapoor A, Kumar S, Tewari S, Garg N, Goel PK. Metabolic syndrome & Framingham Risk Score: observations from a coronary angiographic study in Indian patients. The Indian Journal Of Medical Research 2013;137(2):295-301.
134. Prasad DS, Kabir Z, Dash AK, Das BC. Prevalence and risk factors for metabolic syndrome in Asian Indians: A community study from urban Eastern India. J Cardiovasc Dis Res 2012;3(3):204-11. doi: 10.4103/0975-3583.98895.
135. Luke A, Durazo-Arvizu R, Rotimi C, et al. Relation between Body Mass Index and Body Fat in Black Population Samples from Nigeria, Jamaica, and the United States. American Journal of Epidemiology 1997;145(7):620-8.
136. Deepa M, Farooq S, Datta M, Deepa R, Mohan V. Prevalence of metabolic syndrome using WHO, ATPIII and IDF definitions in Asian Indians: the Chennai Urban Rural Epidemiology Study (CURES-34). Diabetes/Metabolism Research and Reviews 2007;23(2):127-34. doi: 10.1002/dmrr.658.
137. Sandeep S, Gokulakrishnan K, Deepa M, Mohan V. Insulin resistance is associated with increased cardiovascular risk in Asian Indians with normal glucose tolerance--the Chennai Urban Rural Epidemiology Study (CURES-66). The Journal Of The Association Of Physicians Of India 2011;59:480-4.
138. Schisterman EF, Perkins NJ, Liu A, Bondell H. Optimal cut-point and its corresponding Youden Index to discriminate individuals using pooled blood samples. Epidemiology (Cambridge, Mass) 2005;16(1):73-81.
139. Eckel RH, Alberti K, Grundy SM, Zimmet PZ. The metabolic syndrome. The Lancet;375(9710):181-3. doi: http://dx.doi.org/10.1016/S0140-6736(09)61794-3.
140. Rajpathak SN, Gupta LS, Waddell EN, et al. Elevated risk of type 2 diabetes and metabolic syndrome among Asians and south Asians: results from the 2004 New York City HANES. Ethn Dis 2010;20(3):225-30.

141. Dodani S, Dong Y, Zhu H, George V. Can novel Apo A-I polymorphisms be responsible for low HDL in South Asian immigrants? Indian Journal Of Human Genetics 2008;14(1):9-15. doi: 10.4103/0971-6866.42321.

142. Singh GK, Miller BA. Health, life expectancy, and mortality patterns among immigrant populations in the United States. Canadian Journal Of Public Health Revue Canadienne De Santé Publique 2004;95(3):I14-I21.

143. Gupta M, Doobay AV, Singh N, et al. Risk factors, hospital management and outcomes after acute myocardial infarction in South Asian Canadians and matched control subjects. Canadian Medical Association Journal 2002;166(6):717-22.

144. Berry JW, Kim U. Acculturation and mental health. Edtion ed. In: Dasen PR, Berry JW, Sartorius N, eds. Health and cross-cultural psychology: Toward applications. Thousand Oaks, CA US: Sage Publications, Inc, 1988:207-36.

145. Bhugra D. Migration, distress and cultural identity. British Medical Bulletin 2004;69(1):129-41. doi: 10.1093/bmb/ldh007.

146. Wallace PM, Pomery EA, Latimer AE, Martinez JL, Salovey P. A Review of Acculturation Measures and Their Utility in Studies Promoting Latino Health. Hisp J Behav Sci 2010;32(1):37-54.

147. Biro FM, Galvez MP, Greenspan LC, et al. Pubertal Assessment Method and Baseline Characteristics in a Mixed Longitudinal Study of Girls. Pediatrics 2010;126(3):e583-e90.

148. Green SM, Watson R. Nutritional screening and assessment tools for use by nurses: literature review. Journal of Advanced Nursing 2005;50(1):69-83. doi: 10.1111/j.1365-2648.2004.03350.x.

149. Kawada T. Predictive ability of metabolic syndrome for incident cardiovascular disease in non-diabetic subjects. International journal of cardiology 2014.

150. Suinn RM, Khoo G, Ahuna C. THE SUINN-LEW ASIAN SELF-IDENTITY ACCULTURATION SCALE - CROSS-CULTURAL INFORMATION. Journal of Multicultural Counseling and Development 1995;23(3):139-48.

151. Suinn RM, Ahuna C, Khoo G. The Suinn-Lew Asian Self-Identity Acculturation Scale: Concurrent and Factorial Validation. Educational and Psychological Measurement 1992;52(4):1041-6.

152. Lee S, Chen L, He X, Miller MJ, Juon H-S. A cluster analytic examination of acculturation and health status among Asian Americans in the Washington DC metropolitan area, United States. Social Science & Medicine 2013;96(0):17-23. doi: http://dx.doi.org/10.1016/j.socscimed.2013.07.007.

153. Wallace PM, Pomery EA, Latimer AE, Martinez JL, Salovey P. A review of acculturation measures and their utility in studies promoting Latino health. Hispanic Journal of Behavioral Sciences 2010;32(1):37-54. doi: 10.1177/0739986309352341.

154. Reliability and validity of the Suinn-Lew Asian Self-Identity Acculturation Scale with Japanese temporary residents. Japan: Psychologia Society, 1995:17-21.

155. Abe-Kim J, Okazaki S, Goto SG. Unidimensional versus multidimensional approaches to the assessment of acculturation for Asian American populations. Cultural diversity & ethnic minority psychology 2001;7(3):232-46. doi: 10.1037/1099-9809.7.3.232.

156. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. The Lancet 2004;363(9403):157-63. doi: http://dx.doi.org/10.1016/S0140-6736(03)15268-3.

157. Sheikh AJ. Gender and levels of acculturation as predictors of attitudes toward seeking professional psychological help and attitudes toward women among Indians and Pakistanis in America. US: ProQuest Information & Learning, 2001.
158. Narne P, Ponnaluri KC, Singh S, Siraj M, Ishaq M. Relationship between NADPH oxidase p22phox C242T, PARP-1 Val762Ala polymorphisms, angiographically verified coronary artery disease and myocardial infarction in South Indian patients with type 2 diabetes mellitus. Thrombosis Research 2012;130(5):e259-e65. doi: http://dx.doi.org/10.1016/j.thromres.2012.09.012.
159. Nishikawa T, Edelstein D, Du XL, et al. Normalizing mitochondrial superoxide production blocks three pathways of hyperglycaemic damage. Nature 2000;404(6779):787-90.
160. Popkin BM. Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases. The American Journal of Clinical Nutrition 2006;84(2):289-98.
161. Misra A, Khurana L. Obesity and the Metabolic Syndrome in Developing Countries. The Journal of Clinical Endocrinology & Metabolism 2008;93(11_supplement_1):s9-s30. doi: 10.1210/jc.2008-1595.
162. McGuire S. US Department of Agriculture and US Department of Health and Human Services, Dietary Guidelines for Americans, 2010. Washington, DC: US Government Printing Office, January 2011. Advances in Nutrition: An International Review Journal 2011;2(3):293-4.
163. Flegal KM, Carroll MD, Kit BK, Ogden CL. PRevalence of obesity and trends in the distribution of body mass index among us adults, 1999-2010. JAMA 2012;307(5):491-7. doi: 10.1001/jama.2012.39.
164. Heart Disease and Stroke Statistics — 2010 Update. Dallas, Texas: American Heart Association, 2010.
165. Cholesterol Facts. In: Prevention CfDCa, ed.
166. Britten P, Cleveland LE, Koegel KL, Kuczynski KJ, Nickols-Richardson SM. Updated US Department of Agriculture Food Patterns Meet Goals of the 2010 Dietary Guidelines. Journal of the Academy of Nutrition and Dietetics 2012;112(10):1648-55. doi: http://dx.doi.org/10.1016/j.jand.2012.05.021.
167. USDA. internet.
168. Garduño-Diaz SD, Khokhar S. South Asian dietary patterns and their association with risk factors for the metabolic syndrome. Journal of Human Nutrition and Dietetics 2013;26(2):145-55. doi: 10.1111/j.1365-277X.2012.01284.x.
169. Gadgil MD, Anderson CAM, Kandula NR, Kanaya AM. Dietary Patterns in Asian Indians in the United States: An Analysis of the Metabolic Syndrome and Atherosclerosis in South Asians Living in America Study. Journal of the Academy of Nutrition and Dietetics 2014;114(2):238-43.
170. Pérez-Escamilla R. Acculturation, nutrition, and health disparities in Latinos. The American Journal of Clinical Nutrition 2011;93(5):1163S-7S.